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REMEDIAL ACTIONS AT HAZARDOUS WASTE SITES

Survey and Case Studies

By

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FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimonies to the determioration of our natural environment. The complexity of that environment and the interplay of its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution; it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and impoved technology and systems to prevent, treat, and manage wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, to preserve and treat public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research and provides a most vital communications link between the researcher and the user community.

With the passage of Superfund legislation providing for the clean-up of environmental hazards at uncontrolled waste disposal sites, information is needed on the types of remedial actions that have been implemented to date, as well as their effectiveness and cost. This report provides this information by presenting the results of a nationwide survey of 169 such remedial action sites. More specific information on nine of these sites is provided in the form of detailed case studies, also contained herein.

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ABSTRACT

During the Summer of 1980, a nationwide survey was conducted to determine the status of remedial actions applied at uncontrolled hazardous waste disposal sites. Over 130 individuals were contacted to obtain information on such remedial action projects. A total of 169 sites were subsequently identified as having been subject to corrective measures.

Remedial actions were found to have been implemented at many kinds of hazardous waste disposal facilities including drum storage areas, incinerators, and injection wells, but most frequently landfill/dumps and surface impoundments. At the sites receiving such remedial actions, ground water was found to be the most commonly affected media, followed closely by surface water.

Although several types of ~~remedial measures were~~ identified, remedial activities usually consisted of containment and/or removal of the hazardous wastes. Sufficient money was often not available for complete environmental cleanup (e.g., extraction and treatment). The survey determined that a lack of sufficient funds and/or selection of improper technologies was responsible for remedial actions having been applied effectively at only a portion of the uncontrolled hazardous waste disposal sites. Where they had been applied, remedial actions were found to be completely effective only 16 percent of the time.

Nine sites were studied in detail to document typical pollution problems and remedial actions at uncontrolled hazardous waste disposal sites. Of these nine sites, remedial actions were completely effective at two and only partially effective at the other seven. Technologies employed at these nine sites included (1) containment, (2) removal of waste for incineration or secure burial, (3) institution of surface water controls, and (4) institution of ground water controls.

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SUMMARY

INTRODUCTION

Proper disposal and transport of hazardous substances is a major concern of the U.S. Environmental Protection Agency (EPA). Past management of hazardous residues has generally been inadequate and unsound disposal practices have created adverse public health and safety impacts. It has been estimated that 90 percent of all hazardous waste has been disposed of in an unsound manner. Facilities comprising this 90 percent include surface impoundments (48 percent), landfills (30 percent), incinerators (10 percent), and other practices (2 percent). [1-1]

The two laws which provide federal assistance for remedial actions at uncontrolled hazardous waste sites are the Clean Water Act (CWA) and the Resource Conservation and Recovery Act (RCRA). Under Section 311 of CWA, a special contingency fund is available for emergency remedial action at sites where the release of oil or hazardous materials threatens navigable waters. However, land spills that do not directly threaten surface water are not covered under Section 311.

RCRA dictates the manner in which hazardous material may be transported, stored, treated, and disposed. The regulatory thrust of RCRA is currently being placed on identification of abandoned waste sites and abatement of pollution at such sites. Section 7003 of RCRA authorizes EPA to bring suit against legally responsible parties to remedy conditions at sites that present "imminent and substantial endangerment to health or the environment".

The authorities under CWA and RCRA enable EPA to (1) supply limited assistance for enforcement related investigations (e.g., chemical analysis, site investigation, technical assistance); (2) take emergency remedial action where navigable waters are threatened; and (3) take legal action in cases where sites pose an imminent hazard. However, remedial actions at sites where navigable waters are not threatened can only be initiated and funded by states, local governments, and responsible parties. Usually in cases where Section 311 funds are not used, extensive time is involved in identifying the problem, the responsible party, and the remedial measure which is likely to be successful. Even more time is often required in getting the responsible party to clean up such sites, either voluntarily or through court action. The Comprehensive Environmental Response, Compensation and Liability Act (Superfund) was passed and signed into law in December 1980 in order to better address these problems.

PROJECT DESCRIPTION

In an effort to determine the type and effectiveness of past remedial actions at uncontrolled sites, a nationwide survey of on-going and completed remedial action projects was conducted from May to October 1980. The purpose of the survey was to provide information and examples of applied remedial action technologies. Examples provided in the form of case histories identify typical problems, effectiveness, and costs related to implementing remedial action at such facilities.

During the initial phase of the survey, a list was compiled of disposal sites where remedial actions had been or were being implemented. Remedial action sites were identified based upon file and literature review and face-to-face discussions with federal and state personnel. The intent was to compile a list of remedial action sites which (1) represented different remedial action technologies; (2) were located in diverse geographical, geological, and climatological regions; and (3) were fairly effective in resolving the environmental hazard.

In identifying remedial action sites, emphasis was placed upon landfills, surface impoundments, drum storages, incinerators, and deep well injection facilities. If federal or state personnel identified a spill, that site was listed. However, spill sites were not usually sought during the survey, since much of this data is reported yearly in the proceedings from the National Conference on Control of Hazardous Materials Spills.

For the purposes of this survey, a waste burial site was designated as a "landfill" if it was permitted to receive such waste. It was designated a "dump" if it had not been legally permitted. Midnight dumping, roadside dumping, etc., were cited as "dumps", as well as land disposal sites located on company property which had not been officially permitted. Surface impoundments included pits, ponds, and lagoons used for the storage, treatment, or disposal of wastewater or sludge. Injection wells included subsurface disposal wells and for purposes of the survey included such sites as old mine shafts. Incinerators included facilities which dispose of wastes by burning. Spills included events such as liquid disposal into sewers, pipeline spills, railway spills, and other transportation associated spills.

After remedial action sites were identified, the sites were prioritized to determine candidate sites on which detailed case history investigations would be conducted. Factors considered in prioritizing these sites included consideration of (1) legal actions which would hamper in-depth investigation; (2) the extent and nature of the environmental problem associated with the site; (3) the nature and effectiveness of the applied remedial action; and (4) the availability of background data. Subsequently, after the top case history candidates were selected, telephone contacts were made with site owners/operators to verify information and to request permission to visit the site. Permission for a site visit was given for nine of the 19 sites for which permission was requested.

SURVEY FINDINGS

Initially 199 sites were identified as having some form of remedial action. Thirty of these sites were later deleted from the list due to (1) lack of sufficient information, (2) insufficient progress on planned remedial action, and/or (3) the use of "low-technology" remedial actions. "Low-technology" actions were defined to include measures such as (1) merely filling a lagoon with native soil without instituting surface or ground water controls, (2) discontinuing waste receipts at a landfill without attempting to properly close the facility, or (3) clearing a drum storage facility without regard to existing soil or water contamination.

As summarized in Appendix 1-1 to this report, remedial measures identified included a variety of technologies such as containment on-site, chemical treatment (neutralization of acids and bases, precipitation, etc.), biological treatment (land spreading, oxidation ponds, and underground enhancement of native microbes using fertilizer), incineration, and removal and burial in a secure landfill.

The survey indicated that remedial measures usually consisted of containment and/or removal of the hazardous waste. Containment was often approved based upon cost and the concept that it is better to deal with the problem in-place rather than relocate the problem to another locality. Cost was often the prime determinant of the type of technology applied. As a result, the primary remedial goal has been prevention of further contamination of the environment rather than complete cleanup. Complete environmental cleanup can require millions of dollars, sophisticated technologies, and long periods of time.

When hazardous material was contained in its original location, surface water controls were generally constructed (e.g., grading, diversion ditches, revegetation, surface sealing, etc.). In most instances where the ground water was contaminated, a major portion of the waste was removed and sent to a secure landfill or incinerated and surface water controls were constructed to secure the remaining contaminants. Implementation of controls for ground water cleanup is typically more expensive and time-consuming than implementation of surface water controls. Accordingly, ground water remedial measures were implemented at only a few sites. Ground water pumping was the most often applied ground water control at disposal sites while a remedial measure such as a bentonite slurry trench or steel cutoff wall was found at some spill sites.

Tables 1-1 through 1-5 were compiled based on information gathered during the survey. Over 130 individuals were contacted to compile the data. Some of the factors which should be considered in reviewing the data presented in the following tables include: (1) data was based solely upon the immediate survey findings, as reported by individuals contacted; (2) a potential threat was not included in the analysis; and (3) probable (but undocumented) contamination was taken as a positive finding.

Table 1-1 was compiled to indicate the types of disposal facilities which experienced remedial actions. It should be noted that the total number of facilities in Table 1-1 (204) does not coincide with the number of identified sites (169). The higher number is the result of different types of facilities being located on the same property. For example, a landfill, drum storage, surface impoundment, and/or incinerator could all be located at one site. More surface impoundments and landfills were identified as experiencing remedial action than other types of disposal facilities. This would be anticipated since surface impoundments and landfills are the most used types of disposal.

TABLE 1-1. FACILITY TYPE AT REMEDIAL ACTION SITES

	Number of Facilities		
	Status		Total
Facility Type	Active	Inactive	Number
Landfill	16	37	53
Dump	0	27	27
Drum Storage	11	25	36
Surface Impoundment	18	37	55
Injection Well	1	3	4
Incinerator	1	5	6
Spill	0	23	23
Total			204

Table 1-2 was compiled to determine the geographical location of sites which had undergone remedial action. During conversations with federal officials, it became apparent that many factors affect the geographical distribution. For example, industrial waste disposal sites would typically predominate in those states which have more industry. The possibility of a larger number of uncontrolled sites needing remedial measures would increase with an increase in the number of industrial disposal sites. However, the presence of more uncontrolled sites needing remedial measures did not necessarily mean remedial measures were being applied.

TABLE 1-2. LOCATION OF REMEDIAL ACTION SITES

State	Number of Sites
Alabama	2
Alaska	0
Arizona	3
Arkansas	2
California	3
Colorado	3
Connecticut	4
Delaware	2
Florida	7
Georgia	4
Hawaii	0
Idaho	0
Illinois	8
Indiana	3
Iowa	1
Kansas	2
Kentucky	5
Louisiana	3
Maine	2
Maryland	1
Massachusetts	5
Michigan	11
Minnesota	3
Mississippi	0
Missouri	4
Montana	5
Nebraska	0
Nevada	0
New Hampshire	1
New Jersey	10
New Mexico	0
New York	14
North Carolina	7
North Dakota	6
Ohio	4
Oklahoma	0
Oregon	0
Pennsylvania	16
Rhode Island	4
South Carolina	3
South Dakota	0
Tennessee	10
Texas	3
Utah	1
Vermont	0
Virginia	2
Washington	0
West Virginia	1
Wisconsin	3
Wyoming	1
Total 50 States	169

Institution of remedial measures was dependent upon time and force exerted by public officials, as well as the environmental concern of the site's owner/operator. Public awareness and environmental consciousness were strong factors in implementation of remedial measures. Pressure exerted by state officials sometimes forced companies and property owners to implement corrective actions. Since remedial action is generally a time-consuming endeavor, the number of remedial action sites was also dependent upon how long ago the environmental concerns were emphasized. Legal action to identify "responsible" persons for remedial actions generally took four to nine years. After this time, the identified responsible party either instituted remedial actions at the site or declared bankruptcy (in the process refusing to remedy the situation).

Table 1-3 was compiled to obtain an indication of the type of pollution associated with sites which had undergone remedial action. Media affected at the 169 sites were found to include ground water 65 percent of the time, surface water 56 percent, soil 41 percent, air 29 percent, and food chain 12 percent of the time. Frequently a site affected more than one media.

TABLE 1-3. AFFECTED MEDIA AT 169 REMEDIAL ACTION SITES

Affected Media	Number of Occurrences
Ground Water	110
Surface Water	95
Air	49
Soil	69
Food Chain	20
Total	343

Table 1-4 was compiled to identify funding sources. Generally the state, county, and/or municipality attempted to persuade the owner/operator of an uncontrolled facility to voluntarily remedy the environmental hazards. If this effort failed, legal proceedings were instituted against the responsible party. Depending on the degree of hazard posed by the site, various government agencies funded the remedial activities while legal responsibility was determined by the courts. Federal financial assistance for remedial measures is largely funded under Section 311 of CWA. As previously stated, these funds are available only for endangerment of navigable waters. Since any one site might require millions of dollars, total funding from state, county, or municipal sources is unlikely. As a result of these high costs, more than one party often funded the remedial activity.

TABLE 1-4. FUNDING SOURCES AT 169 REMEDIAL ACTION SITES

Funding Source	Number of Occurrences
Federal	44
State	62
County	11
Municipal	22
Private	103
Total	242

Table 1-5 was compiled to determine the general status of improvement that occurred at sites which had undergone remedial actions. A total of 180 separate remedial action efforts were initiated at the 169 sites. The pollution status was considered unimproved when the implemented remedial measure did not correct the contamination problem. Usually, lack of improvement was the result of inadequate funds or the type of action instituted. Improved refers to a remedial measure which may have partly corrected the problem, but some problems are still experienced at the site. A remedied site was one at which the problem had been corrected; e.g., contaminated surface water was returned to its natural state. Based on these definitions, the last column in Table 1-5 indicates that 46 percent of corrective actions were not effective, 38 percent improved the pollution problem, and 16 percent were completely effective.

TABLE 1-5. POLLUTION AND REMEDIAL ACTION STATUS AT 169 SITES

Pollution Status	Number of Remedial Actions: Planned Actions	On-Going Actions	Completed Actions	Total
Unimproved	16	49	17	82
Improved	12	36	21	69
Remedied	0	3	26	29
Total	28	88	64	180*

* A total of 180 remedial activities were identified at the 169 sites.

CASE STUDY FINDINGS

Case study sites included in the report were selected based on a desire to represent a wide range of facility types, pollution type and media, and remedial action technology. Tables 1-6 and 1-7 present an overview of the nine case histories. The nine sites include two remedied and seven improved sites. Remedial action applied at the seven improved sites showed varying degrees of effectiveness. The combination of all nine sites covered contamination of all media including ground water, surface water, soil, air, and the food chain. Waste types involved included mercury, arsenic, solvents, oil, tire wastes, inorganic and organic waste, and septic waste. The types of facilities examined included surface impoundments, landfills, drum storages, and incinerators. The technology employed consisted mainly of containment, removal of waste for incineration or secure burial, and institution of surface water and/or ground water controls.

CONCLUSION

Remedial measures encountered during this survey were usually confined to containment and/or removal of the hazardous

TABLE 1-6. CASE STUDY SITE IDENTIFICATION

Site No.	Name	Location	Waste Type	Remedial Action Technology
A	Olin Corporation	Saltville, PA	Mercury	Graded and constructed erosion conrol structures. Removed contaminants. Planning extensive remedial action ($23 million).
B	Firestone Tire and Rubber	Pottstown, PA	Tires, SO_2 scrubber waste, organic waste, pigments, PVC sludge	Recovery wells intercepted polluted ground water and recycled it through their plant. Expected to be 100 percent effective.
C	Anonymous	East Central, NY	Solvents, oils, paint waste with PCB	Lagoons filled and capped. Diversion ditches and test wells installed.
D	Destructo/Carolawn	Kernersville, NC	Volatile/flammable waste	Two Phases: 1. Waste removed, incinerated or landfilled. Contaminated soil removed and landfilled. 2. Waste removed, incinerated, landfilled, and deep well injected.
E	Whitmoyer Laboratories	Myerstown, PA	Arsenic compounds	Removed arsenic waste from lagoon, treated and discharged. Waste piles of arsenic placed in concrete vault. Ground water treated using purging wells. Some contaminated soil remains.
F	Western Sand and Gravel	Burrillville, RI	Septic plus hazardous wastes	Four lagoons pumped, dried, and contents stored off and on-site. Monitoring wells installed. Future remedial action planned.
G	Ferguson Property	Rock Hill, SC	Solvents, heavy metals	Two Phases: 1. Contained with polyethylene and clay cap. Installed surface water diversion ditches and vent pipes in contained area. 2. Since phase one ineffective, removed liquid. Still some sludge and drums left.
H	3M Company	Woodbury, MN	Spent solvents, acid sludge	Pits emptied and contents burned. Barrier wells installed to stop spread of contaminated ground water.
I	Whitehouse/Allied Petroleum	Jacksonville, FL	Oil, PCB	Mobile activated carbon unit dewatered pit, oil absorbed using solid waste and earth. Future remedial action planned.

TABLE 1-7. CASE STUDY SITE BACKGROUND

	Facility Type							Status		Pollution: Affected Media					Pollution: Status			Remedial Action: Funding					Remedial Action: Status			Litigation		
Site No.	Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incineration	Spill	Active	Inactive	Ground Water	Surface Water	Air	Soil	Food Chain	Remedied	Unimproved	Improved	Federal	State	County	Municipal	Private	Completed	On-Going	Planned	Current	No	Expected
A	x			x					x	x	x		x				x					x	x		x		x	
B	x			x				x		x	x		x		x							x		x			x	
C	x			x					x	x	x	x	x	x			x					x	x		x		x	
D			x			x	x		x		x	x		x			x	x					x			x		
E	x			x					x	x	x		x				x					x	x				x	
F				x					x	x	x	x	x				x	x	x					x	x		x	
G			x						x				x				x	x					x	x		x		
H				x					x	x					x							x		x			x	
I				x			x		x	x	x		x	x			x	x	x		x		x	x	x		x	

wastes with a primary goal being the prevention of further contamination of the environment rather than complete cleanup. Complete environmental cleanup of ground water or surface water generally requires sophisticated technology, additional money, and additional time. Therefore, a responsible party with sufficient funds and expertise must be located for complete cleanup to occur. In most cases sufficient funds have not been available for effective remedial action. The U.S. EPA is able to provide only limited funds under Section 311 of the CWA. States and local governments typically cannot provide sufficient money for total cleanup, since any one site may require millions of dollars to correct.

Based on the case studies and survey, the state-of-the-practice in remedial action does not look favorable when one considers that 46 percent of the time the applied remedial action was ineffective and only a portion of all uncontrolled sites have received some form of remedial action. In addition, remedial action applied at a site experiencing problems was found to be totally effective only 16 percent of the time.

It should be emphasized that the numbers presented in this section are based on assumptions by the persons performing the survey and the opinions of those interviewed. However, the percentage numbers are a fairly accurate representation of the state-of-the-practice in remedial actions.

SUMMARY REFERENCES AND BIBLIOGRAPHY

1-1 Connery, Jan. "Draft Report on Review of Uncontrolled Site Response, Public Information Document". Energy Resources Company, Inc. Cambridge, Massachusetts. April 4, 1980.

APPENDIX 1-1

REMEDIAL ACTION HAZARDOUS WASTE SITES BY STATE

Name and Location	Facility Type: Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incinerator	Spill	Waste Type	Remedial Action Technology
Army Redstone Arsenal (Olin Chemical Plant) Huntsville, AL	x			x				PCB/D DT	Plant shut down in 1970, cleaned in 1979
Kevlar Waste Storage Site Anniston, AL			x					Sulfuric acid, spent dope waste.	Drums removed, soil removed and treated with lime. Site limed. Berm constructed to control runoff.
18-Acre Vacant Lot Phoenix, AZ		x						Arsenic.	Cleaned soil.
Tri-City Landfill Phoenix, AZ		x						Hazardous waste and heavy metals.	Removed wastes.
Mountain Home View Estates Globe, AZ								Asbestos dust.	Demolished mills, covered asbestos with dirt, revegetated.
Vertac Chemical Corporation Jacksonville, AR	x	x	x	x				Pesticides, phenols, herbicides, dioxin.	Built interceptor ditch and installed monitoring wells. Building additional interceptor ditches and will cap site.
Gurley Refining Company Edmondson, AR				x				PCB, zinc, heavy oil sludge.	Waste neutralized with lime. Need to recycle waste or cap site.
Koppers Company, Inc. Butte County, CA				x				Creosote, PCP	Triple lined lagoons. Installed recovery wells.
Stringfellow Industiral Waste Disposal Site Riverside County, CA				x				Organic and inorganic residues.	Built dam to contain waste, leakage detected below dam. Waste and contaminated soil currently being removed.
Moly Corporation Mountain Pass Operations San Bernadino County, CA				x				Lead and zinc.	Installed a cement cut-off barrier and pumped contaminated water.
Rocky Mountain Arsenal Denver, CO				x				Pesticides, herbicides.	Drainage corrected. Recycling. Containment of ground water, lined impoundment, closure.
Lowry Landfill Denver, CO	x							Chemical waste.	Monitor. Cleanup initiated.
City of Denver, CO	x							Landfill gas.	Monitoring. Placed barriers.
Fitzgerald Gasket Company Torrington, CT	x							Asbestos.	Removed waste.
Gallup Dump Plainfield, CT	x		x					Acetate, organics, heavy metals.	Cleanup included general containment.
Chemical Waste Removal Bridgeport, CT			x					Chemical wastes.	Removed wastes.
Pioneer Products East Haddam, CT	x							Hydrocarbons.	Practices corrected.
Diamond Shamrock Corporation Delaware City, DE				x				Mercury wastes.	Monitoring. Removal of water. Capped and seeded.
Llangollen (Army Ck) Landfill Wilmington, DE	x							Heavy metals and hazardous wastes.	Capped. Aquifer reclamation, aeration, monitoring.
Broward Chemical Company Ft. Lauderdale, FL				x				Calcium hydroxide sludge.	Higher berms constructed. Site regrading to control sludge planned.
North Miami Beach, FL							x	Organosulfate	Wells closed, system flushed, treated with activated carbon.

Name and Location	Facility Type: Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incinerator	Spill	Waste Type	Remedial Action Technology
Gulf Coast Lead Tampa, FL		x						Acid, lead.	Dumping practice changed. Acid neutralized. Plan to recovery lead.
Whitehouse Waste Oil Pits (Allied Petroleum Pits) Jacksonville, FL				x			x	Oil, PCB.	Mobile activated carbon unit dewatered pits, oil absorbed using solid waste and Fuller's Earth.
Piper Aircraft Corporation Vero Beach, FL				x				Trichloroethylene	Repaired tanks. Ground water volatilized.
Gainsville, FL				x				Phenol	Lagoons covered. Parking lot on top. Since phenol problem, no remedial action instituted.
Taft, FL			x					Pesticides	Barrels removed, contaminated area treated.
Gordon Service Company Gordon, GA	x							Acid, heavy metals, organics, inorganics.	Preliminary assessment underway. Monitoring wells installed.
General Electric Rome, GA							x	PCB.	Removed waste.
Vacant Lot Lake City, GA		x						Explosive chemicals.	Drums removed. Waste detoxified.
Ft. Gillem Old Landfill Atlanta, GA	x							Narcotics, oils.	Cover material placed on top.
Kerr-McGee Disposal Site West Chicago, IL		x		x				Hazardous waste, radioactive waste, ThO_2 and V_3O_8.	Chemicals removed to approved site and are negotiating for cleanup of radioactive wastes.
Monsanto Chemical Co. Dump East St. Louis, IL				x				Phenols, nitrobenzene, sulfuric acid, fly ash.	Site closed and covered with 4-6 ft of clay and seeded. Monitoring wells installed. Chemicals removed to approved site.
U.S. Drum Corporation Chicago, IL			x					Liquid/industrial waste, resin, paint and pigment waste.	Some drums removed. Liquid contaminants stored in water-tight containers.
Banner Landfill Rockdale, IL	x							Municipal/industrial waste.	Leachate collected and recirculated through landfill.
Shamrock Environmental Services Will County, IL	x							Heavy metals.	Treatment lagoon, clay-lined, drainage pattern changed, area reseeded and leachate collected in tank trucks and treated on-site.
Texaco Oil Company Richland County, IL					x			Phenol.	Contaminated soil removed.
Johnson Property Byron, IL		x						Industrial waste, cyanide, heavy metals.	Drums removed, earthen dams and trenches constructed to confine runoff which was treated with calcium hypochlorite to destroy cyanide. Monitoring program instituted.
Hyon Waste Management Chicago, IL			x					Mixed chemicals.	Drums removed.
Seymour Recycling Seymour, IN			x					Mixed chemicals.	2,700 ft waist high trench constructed to contain waste. Sand and charcoal filters to contain waste.
Bloomington South Wastewater Treatment Plant Bloomington, IN							x	PCB.	Building new wastewater treatment plant. Will replace sewer lines.
Conrail Derailment Inwood, IN							x	Hazardous chemicals	Initiated ground water purging and carbon filtration, soil removed. Ground water monitored.

Name and Location	Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incinerator	Spill	Waste Type	Remedial Action Technology
LaBounty Dump Charles City, IA		x						Orthonitroanaline arsenic.	Ground water monitoring system installed. Future remedial action planned.
Vulcan Materials Company Wichita, Kansas				x		x		Chlorinated organics.	Encapsulated landfill and graded. Purging and treating ground water, then injecting into disposal wells. Surface water treated.
National Zinc Company Montgomery County, KS								Heavy metals and sulfuric acid.	Chemical treatment of land with lime and precipitation of heavy metals.
Goodyear Dump Berea, KY	x							Asbestos, heavy metals.	Barrels removed. Contaminated soil removed.
Raywick Chemical Dump Site (Allan Dump) Raywick, KY		x						Solvents	Flammable material sent to incinerators, non-hazardous waste disposed in Lebanon Landfill. Burial site reclaimed and revegetated.
Messingschlager Farm Covington, KY		x						Solvents.	Barrels removed.
Lees Lane Landfill Louisville, KY	x							Combustible gas.	Extraction system installed.
Campground Landfill Louisville, KY	x							Combustible gas.	Extraction system installed.
Southeastern Chemical Corp. Reserve, LA			x					Chlorosulfonic acid, hydrocarbons.	Removed 2 trucks of liquid waste, assessment is completed and future closure being planned.
Cleve-Reber Sorrento, LA	x							Corrosive waste and volatiles.	Runoff controlled with dike - only in preliminary stage of assessment.
Vulcan Materials Corporation Darrow-Geismar, LA	x							HCB	Stopped previous practice and are burying waste on-site. Emissions of HCB into the air have been reduced. Have covered previously used landfills which received HCB wastes with 4-6 ft soil and a polyethylene film placed 2 ft below surface. Storing HCB wastes underwater in a lagoon and subsequently landfilling utilizing above cover.
Mr. O'Conner's Junk Yard Augusta, ME	x							PCB.	Capped.
McKin Company Gray, ME				x				Waste oils.	Wells capped. Water supply extended to homes. Cleanup completed.
Norris Farm Landfill Dundolk, MD	x			x				Sulfides and organic wastes, hydrogen sulfide.	Neutralization. Covered and graded.
H&H Drum Company Chemical Waste Warehouses and Disposal Site Dartmouth, MA		x	x					Chloroform, organics, ketone, toluene, etc.	Criminal action. Removed soil and chemicals.
Silresim Lowell, MA			x	x				Solvent waste oils, plating wastes, toxic metals.	Contained. Berms constructed. Monitoring.
Merrimac Chemical Company Woburn, MA	x						x	Solvents, tannery wastes.	Analysis. Initial stage of cleanup.
Bankrupt Waste Hauler Dorchester, MA			x					Chemical wastes.	Removed waste.
Shad Factory Pond Rebohoth, MA		x						Toluene, trichloroethylene, ethyl acetate.	Cleanup initiated.

(Facility Type: Landfill, Illegal Dump, Drum Storage, Surface Impoundment, Injection Well, Incinerator, Spill)

Name and Location	Facility Type: Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incinerator	Spill	Waste Type	Remedial Action Technology
Chesapeake & Ohio Railroad Derailment Pearl, MI							x	Styrene.	Slurry trench, aeration, monitoring wells, and purging wells initiated.
Chesapeake & Ohio Railroad Derailment Woodland Park, MI							x	Phenol, ethylene oxide, vinylidene chloride.	Carbon filtration, aeration, and ground water pruging initiated.
Anderson Development Adrian, MI				x				Curene 442.	Vacuum-swept homes and streets. Partial cleanup of site.
Oakland County Dump Sites Oakland County, MI		x						Numerous chemicals.	Some drums removed or containerized.
Bofars Lakeway, Inc. Muskegon, MI				x				Amines, benzene, toluene.	Purged ground water.
Cordova Chemical Company Muskegon, MI		x	x	x				Pharmaceutical intermediates, herbicides, pesticides, synthetic musks.	Drums being removed. Ground water purged.
Hooker Chemical Company Montaque, MI		x	x	x				Brine, asbestos, fly ash, deadly pesticides.	Wastes and contaminated soil will be placed in a vault being constructed. Ground water purging will be continued for 50 years.
Wurtesmith Air Force Base Oscoda, MI							x	TCE.	Leaky tank repaired. Ground water cleanup planned.
Hedblom Industries Oscoda, MI		x		x				TCE.	Public water supplied to residents. Drums moved to shed.
Central Landfill Montcalm County, MI	x							Metal plating waste C-56.	Excavated tanks and contaminated soil removed.
Chemical Recovery Wayne County, MI			x					Mixed chemicals.	Approximately 5,000 drums removed. Intercept trench built - failed - new one being built.
Pollution Controls Shakapee, MN			x					Combustible paint sludges, solvents, and waste oils.	Have removed some drums, will remove all drums and dispose of contaminated soil.
3M Company Woodbury Village, MN				x				Spent solvents, acid sludge (isoprophyl ether).	Barrier wells installed which continuously pump water to stop continued spreading. Lagoons emptied.
Reilly Tar & Chemicals Co./ Republic Creosoting Company St. Louis Park, MN		x		x			x	Tars and creosote.	Preliminary assignment of contamination. Wells capped and excavated material.
Verona, MO							x	Dioxin.	Excavated soil.
Albert Harris Property Dittmer, MO		x						Oil/PCB waste.	Excavated pit, pit sealed. Cleaned debris from stream bed. Water treated using carbon absorption.
St. Joseph, MO		x						Alcohols, solvents, chrome sludge.	Drums removed and sent to a secure landfill.
Conservation Chemicals Company Kansas City, MO				x				Pickle liquor, fly ash.	Lagoons closed and stabilized, and will be covered with asphalt.
Montana Radiation Butte, MT	x							Radioactive phosphate slag.	Gamma monitoring. Cleanup initiated.
Montana Radiation Anaconda, MT	x							Radioactive phosphate slag.	Gamma monitoring. Cleanup initiated.

	Facility Type								
Name and Location	Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incinerator	Spill	Waste Type	Remedial Action Technology
Diamond Asphalt Company Chinook, MT	x							Oil compounds, sludge and liquid.	Closed and contained.
Kalispell Landfill Kalispell, MT	x						x	PCB, polyester resin.	Diked and removed.
Mouat Industires Columbus, MT	x							Toxic solids.	Removed waste. Ongoing assessment.
Cross Road Landfill, NH	x							Phenols.	Lime addition. Extention of public water supply lines.
Reich Chicken Farm Dover Township, NJ		x						Petrochemicals, toxics, flammables.	Removed drums and soil. New wells drilled.
Battery Operation Elizabeth, NJ							x	Lead dust.	Removed lead and lead contaminated soil.
Sherwin Williams Company Gibbsboro, NJ				x			x	Lead, mercury.	Contained and removed.
Chemical Control Corporation Elizabeth, NJ			x					Solvents, organics, inorganics.	Removal of waste.
Kin-Buc Landfill Scotch Plains, NJ	x			x				Solvents, organics, inorganics.	Regraded, discharge controlled. Monitoring.
Martin Landfill Middletown Township, NJ							x	Petroleum wastes.	Cleanup initiated.
Jones Industrial Services Landfill South Brunswick, NJ	x							Petroleum wastes, chemical wastes.	Closed. Removed or contained.
Unknown Name Winslow, NJ				x				Phenols.	Emptied older lagoon and lined new lagoon.
Ortho Pharmaceutical Company Bridgewater Township, NJ				x				Volatile liquid organics.	Closed and removed.
NFS (Nuclear Fuels Services) West Valley, NY	x		x	x	x			Radioactive "low" and "high".	Closed and improved. Removed waste.
General Electric Company Hudson Falls & Ft. Edward,NY	x			x				PCB.	Removed soil and wastewater from impoundment.
FMC Corporation Middleport, NY	x			x				Arsenic, ammonia.	Regraded and drained impoundment.
Gas Storage Tanks Long Island, NY							x	Gasoline.	Removed waste. Biostimulation instituted.
Anonymous Landfill East Central NY	x			x				Solvents, oils, paint waste, PCB.	Filled lagoons, diversion ditches, and test wells installed. Capped.
Phelps-Dodge Refining Company New York City, NY	x							Nickel and copper.	Removed waste.
Necco Park Landfill Niagara Falls, NY	x							Barium organics.	Drained, capped, seeded.
Love Canal Chemical Landfill Niagara Falls, NY	x							Chemical (organic and inorganic)	Drained. Assessment initiated.
Hyde Park Landfill Niagara Falls, NY	x							Chemical (organic and inorganic)	Closed. Constructed leachate collection system. Removed soils, eliminated outer berm, berm containment, drainage system, removed waste, incorporated cover.

Name and Location	Facility Type: Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incinerator	Spill	Waste Type	Remedial Action Technology
102nd Street Landfill Niagara Falls, NY	x							Pesticides, phosphorous chlorates.	Soil cover used in closure.
Hudson Valley PCB Sites 1. Caputo RDA	x							PCB.	Runoff controlled, regraded, capped. Removed wastes.
2. Ft. Edward Landfill	x							PCB.	Runoff leachate controlled and treated. Capped.
3. Kinsbury Landfill	x			x				PCB.	Regraded, capped, grout-curtain wall, well point system, leachate controls installed.
4. Ft. Miller RDA - operating	x							PCB.	Capped, reburied wastes.
5. Old Fort Edward RDA	x							PCB.	Removed wastes.
Vanderhorst Co., Plant No. 1 Olean, NY	x							Chromium.	Removed wastes.
Allied Chemical Onondoga County, NY				x				Mercury	Cleaned up lake.
Pollution Abatement Services, Inc. Oswego, NY			x	x				PCB, chloroform, toluene, etc.	Constructed dike and trench for leachate control, removed wastes, filled impoundment.
Destructo Chemway Corporation (Carolawn Co., Inc.) Kernersville, NC			x			x	x	Fuel oil, toluene, xylene, dichloroethane, trichlorethene.	One-third of waste chemicals removed. 32,000 ft^3 contaminated soil removed. New drinking water supply system constructed.
"North Carolina Highway Spill" Raleigh, NC							x	PCB.	Sprayed activated carbon and covered the area with asphalt.
Koppers Company, Inc. Morrisville, NC				x				Pentachlorophenol (PCP).	Contaminated soil/waste removed. Still some contaminated soil on site.
Renroh Warehouse Holly Ridge, NC			x					2-4 dinitrophenol.	Removed drums.
Summit Avenue Charlotte, NC		x						Waste chemicals, solvents, plating wastes.	Removed drums.
Haywood County Clinton, NC	x						x	Petroleum based cleaning fluid.	Surface skimming of water.
Carolina Task Cleaning Company Greensboro, NC							x	Solvent rinses.	EEB cleanup of waterway. Pit cleaned up.
Arsenic Disposal North Dakota	x		x					Arsenic.	Collected and recycled waste.
Belfield-North Ashing Site Belfield, ND	x							Radioactives and heavy metals.	Preliminary study. Cleanup initiated.
Belfield-South Ashing Site Belfield, ND	x							Radioactives and heavy metals.	Preliminary study. Cleanup initiated.
Husky Industries Dickenson, ND				x				Organic residues.	Preliminary study. Cleanup initiated.
Sodium Chromate Dickenson, ND					x			Chromium.	Monitoring. Cleanup initiated.
North Dakota University at Fargo Minot, ND	x							Toxics, radioactives, flammables.	Monitoring. Cleanup initiated.
Summit National Liquid Services Pontege County, OH			x					Chemical waste oils, acetone,	Containment, drainage instituted, redrummed, and removed wastes.
Chem-Dyne Corporation Hamilton, OH			x					Solvents, organics, inorganics.	Removing wastes and site cleanup.

Name and Location	Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incinerator	Spill	Waste Type	Remedial Action Technology
	Facility Type								
Chemicals & Minerals Relcamation Cleveland, OH		x	x					Solvents, organic and inorganic.	Removed drums.
Pristine, Inc. Reading, OH			x			x		Mixed hazardous chemicals	Some drum removal and site cleanup.
Ambler Water Company (New Jersey Zinc) Ambler, PA							x	Gasoline spill.	Aquifer recycling. Added phosphate as fertilizer to ground to accelerate biodegradation.
Kawecki Berylco Industries, Inc. (KBI) Hazle Township, PA				x				Beryllium sludge.	Treating collected ground water, site capped.
National Wood Preservers Haverford, PA				x	x			PCP, oil.	Impoundment filled and graded.
Nease Chemical Company State College College Township, PA				x				Heavy metals, kepone, mirex.	Initial cleanup created a kepone problem which is ongoing.
Transformer Sales Youngsville, PA			x					PCB, organics.	PCB material placed in new drums. Building has new roof and concrete floor pad. Berm constructed around building. Soil being evacuated.
Revere Chemical Corporation Nackamixon, PA					x			Acids, heavy metals.	Waste neutralized, removed, sent to sea. Lagoons backfilled. Soil at site still contaminated.
Tobyhanna Army Depot Coolbaugh Township, PA	x							Electroplating (cyanide hexavalent chromium)	Closed, regraded, changed pre-landfilling technique.
Firestone Tire & Rubber Company Pottstown, PA	x			x				Refinery, SO_2 scrubber wastes, organic waste.	Contaminated ground water recirculated and used in plant processes.
Hill Service, Yukon Plant Southington Township, PA				x				Pickle liquor sludge.	Practice corrected, closure plans being developed.
ABM Company - Wade Site Chester, PA	x		x					Volatile organics hydrochloric acid, PCB, cyanide, benzene.	Determined extent of problem. Materials disposed above natural grade. Hot spots removed. Runoff discharge prevented.
Elkland Tannery Site Elkland, PA				x				Sulfuric acid, tannic acid, lime and sodium hydroxide.	Material removed, lagoon backfilled.
Rohm-Haas Company (Whitmoyer Labs) Myerstown, PA	x			x				Arsenic compounds.	Removed arsenic waste from lagoon, treated and discharged. Waste piles of arsenic placed in concrete vault. Ground water treated using purging wells. Some contaminated soil remains.
Environmental Aids New Beaver Burrow, PA				x				Pickle liquor, organic sludge.	Removed waste and chemically treated. Limed pond. Revegetated.
Ohio River Park Neville Island Pittsburg, PA	x							Upgrading to landfill led to release of noxious fumes.	Closed park off. Monitoring gas and ground water. Material removed.
"1977 Flood" Johnstown, PA							x	Oil, organics.	Containment. Activated carbon for water treatment.
Foote-Mineral Exton Corporation Whiteland, PA				x				Lithium.	Lagoons lined. Activated carbon for water treatment

Name and Location	Facility Type							Waste Type	Remedial Action Technology
	Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incinerator	Spill		
Western Sand and Gravel North Smithfield & Burrilville, RI				x				Chemical, septic.	Emptied lagoons. Removed soil. Use of BarCad wells.
Candybox Farm (Piccillo) Coventry, RI		x						Ferric chloride, sodium, aluminum, benzene, toluene.	Drums removed.
Bristol Landfill Bristol, RI	x	x						Chemical solvents	Drums removed.
Capuano Landfill (Sanitary Landfill, Inc.) Cranston, RI	x		x	x				PCB, organics, liquid and industrial wastes.	Removed standing water, installed barriers.
Ferguson Property Rock Hill, SC			x					Solvents, paints, inks.	Remedial action in two stages: (1) encapsulated site temporarily to prevent runoff into nearby stream, (2) since 1 above was ineffective, liquid was removed and sent to a solvent reclaimer.
Chapel Estates Greer, SC			x					Paints, solvents, dyes, inks.	Drums removed with some contaminated soil removed.
Fort Lawn, SC			x					Volatile chemical waste, paints and solvents.	Some drums removed.
Velsical Residue Hill Chattanooga, TN				x				Pesticide wastes.	Grading, capping, revegetating the area. Possible backflush planned to minimize impact on ground water.
Bumpass Cove Landfill Jonesboro, TN	x					x		Industrial waste.	Drums removed and incinerator shut down. Landfill no longer accepting industrial waste. Plan to regrade, cap, and revegetate landfill.
Velsicol Chemical Corporation Hardeman County, TN		x						Pesticide wastes.	Grading, capping, revegetating the area. Possible backflush planned to minimize impact on ground water.
Milan Army Ammunition Plant Milan, TN				x				Explosive residues.	Pits covered.
Accidental Spill of Askarel East TN							x	Askarel.	Soil removed. Area covered with top soil, seeded, and landscaped.
Waynesboro City Dump Waynesboro, TN	x							PCB waste.	Site fenced, covered, regraded, and planning future closure.
Millington Dump Landfill Memphis, TN	x							Pesticides and herbicides.	Site closed in 1976. Clean fill imported. Since then land used to grow soybeans.
North Hollywood Site Memphis, TN	x							Unknown types of industrial waste.	Visible drums removed and completion of surface water control. Future efforts to monitor ground water and surface water.
Meryville Pike Knoxville, TN	x							Plastic polymers.	Surface diversion initiated to prevent rainwater runoff. Capping, revegetation, and silt control measures used.
Motco, Inc. LaMarque, TX		x	x	x				Styrene tars, vinyl chloride, heavy metals.	Some styrene tars removed. Vinyl chloride contamination continues.
DuPont-Ingleside Corpus Christi, TX	x			x	x			Carbon tetrachloride, Fluoride, arsenic, chloride.	Two surface impoundments relined. Purged ground water treated with sodium hydroxide or disposed in injection wells.

Name and Location	Landfill	Illegal Dump	Drum Storage	Surface Impoundment	Injection Well	Incinerator	Spill	Waste Type	Remedial Action Technology
Bio-Ecology Systems, Inc. **Grand Praire, TX**	x	x	x	x		x	x	Arsenic, chromium, copper, lead, zinc, nickel, etc.	Removed drums. Drained lagoons. Filled and graded.
Little Mountain Salvage Yard **Ogden, UT**	x			x				Oils.	Removed, treated and redisposed of wastes. Site was capped and graded.
Spill **Plains, VA**		x					x	Pesticide.	Recycled and treated waste.
Olin Plant **Saltville, VA**	x			x				Mercury and alkalide products.	Graded, constructed erosion controls. Removed contaminants.
Train Derailment - Spill **Williamstown, WV**							x	Hydrochloric acid, mother liquor, formaldehyde.	Contained and removed.
Weiseter Construction **Calumet County, WI**		x						Demolition wastes, PCB's, mercury, lead, cadmium.	Contaminated soil being removed.
Ansul Company **Marinette, WI**		x						Arsenic salts.	Treated and removed wastes.
Tecumseh Products Company **Sheboygan Falls, WI**	x							PCB's.	Contaminated soil stored in warehouse.
Amoco Refinery Plant **Casper, WY**	x		x	x				Oils.	Closed. Contamination removed and monitoring is ongoing.

Facility Type: Landfill, Illegal Dump, Drum Storage, Surface Impoundment, Injection Well, Incinerator, Spill

SECTION 2

SITE A
OLIN CORPORATION
SALTVILLE, VIRGINIA

INTRODUCTION

A chemical production complex located in Saltville, Virginia was established in 1895 and operated continuously until its closure in 1970 by the final owner/operator, Olin Corporation. Major product streams generated by the facility over its operational life included soda alkali, chlorine, hydrazine, and dry ice.

Operation of the now-closed chemical complex resulted in total dissolved solids (TDS) and mercury pollution in the nearby North Fork of the Holston River. The TDS pollution has been traced to several ponds on the property used by plant owners for disposal of their manufacturing wastes. The mercury pollution has been traced to an old chlorine plant on the complex (since demolished) and one of the above-cited ponds.

Mercury is the pollution problem of chief concern. Although plant officials and regulatory authorities had been aware of the mercury problem for many years, the problem was not seriously addressed until 1976 when it became obvious that mercury in the North Fork bottom sediments was not decreasing through natural dispersive processes.

Subsequently, environmental engineering studies indicated that soil erosion from the chlorine plant area represented a major pathway of mercury to the North Fork. Accordingly, erosion control measures at the old plant site were implemented by Olin Corporation. These measures were apparently effective in controlling further mercury discharges from the chlorine plant site. However, TDS and mercury discharges are continuing from the ponds, and measures to control these discharges are now being considered. Even after all further mercury and TDS discharges from the chemical complex site are controlled, some remedial actions will have to be performed to control settled mercury in riverbed sediments downstream.

SITE DESCRIPTION

The Olin Chemical complex is located in the Saltville Valley in southwestern Virginia. The plant location is shown in an aerial photograph included as Figure 2-1; the layout of facilities at the complex is shown in Figure 2-2.

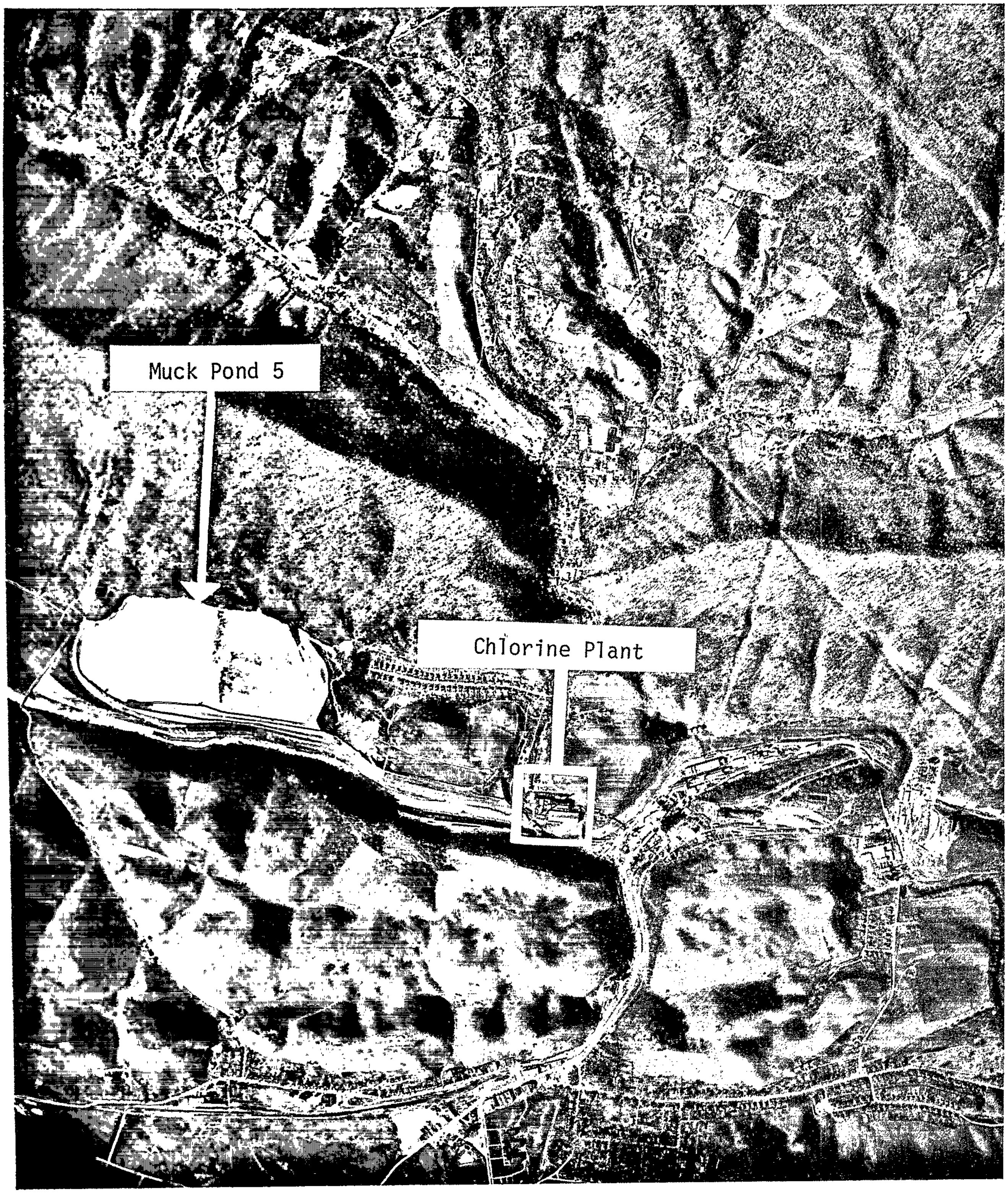

Figure 2-1. Aerial photograph of Olin Chemical complex. [2-1]

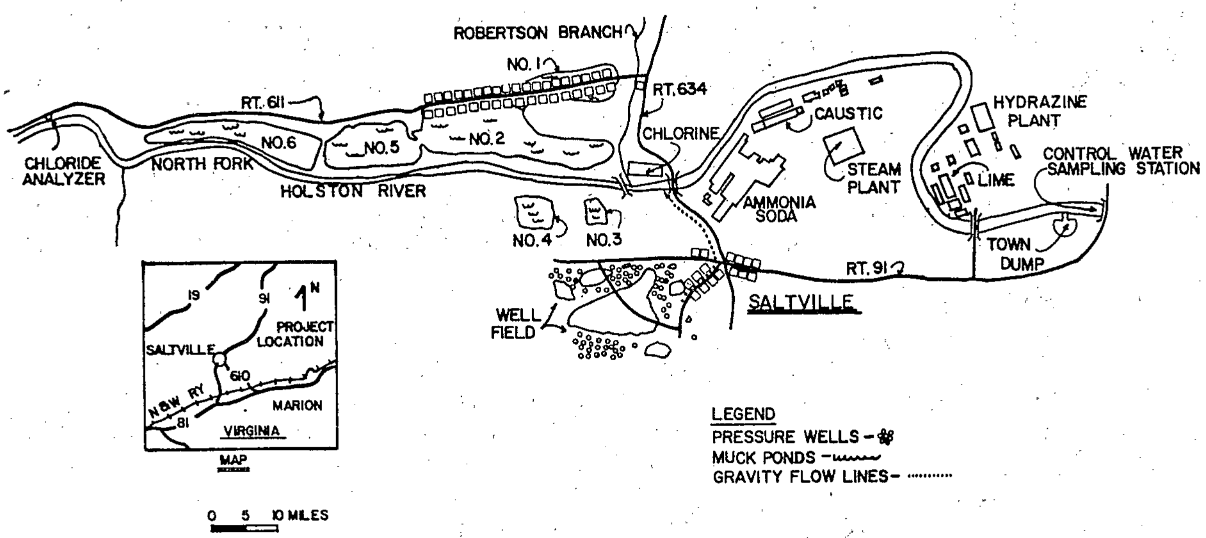

Figure 2-2. Site layout of Olin Chemical complex. [2-2]

The average annual rainfall in the area is 109 cm (43 in.) and average annual snowfall is 38 cm (15 in.). The average daily high temperature is 13°C (55°F) with the highest daily maximum in July at 29°C (85°F) and the lowest in January at -4°C (25°F).

The small town of Saltville lies in the belt of the faulted and folded Appalacian Mountains. Saltville and the former Olin plant site lie in the flood plain of the North Fork of the Holston River. Underlying the site is the MacCrady Formation, a shaley limestone of Mississippian Age. The MacCrady Formation contains evaporite deposits of high quality halite (rock salt) and occupies a narrow bank less than 300 m (1,000 ft) wide. This Formation supplied salt to the brine wells located on the plant property.

East of the former chlorine plant site, the MacCrady Formation thickens to about 600 m (2,000 ft) as a result of flowage of the evaporites during thrust faulting. The strike of the MacCrady is 55° NE with a dip ranging from 45° to 60° SE. The North Fork flows to the southwest following the bedrock strike and is underlain by the MacCrady Formation.

The Little Valley Formation, resistant limestone of Mississippian Age, overlies the MacCrady Formation. This limestone outcrops and forms the cliff and ridge between the former plant site and the Town of Saltville, southeast of the North Fork. Northwest of the river valley is Little Mountain formed by the resistant Price Sandstone of Mississippian Age, which underlies the MacGrady Formation. In the river valley, alluvium overlies the bedrock and consists mostly of sandstone boulders in silty and sandy clay.

Figure 2-3 displays a generalized geological cross section of the area in which the plant was located. The alluvial material may have been removed from some areas of the plant grounds during initial site preparation. Presently, most of the former chlorine plant site is underlain by loose fine grained fill consisting of clayey silt and sand and some pieces of building materials.

The North Fork is located on the southeast side of the Olin property and separates the former plant site from Saltville; it originates from springs and streams near the town of Nebo, Virginia about 64 km (40 mi) northeast of Saltville. As shown in Figure 2-4, it flows southwest for about 209 km (130 mi) to Kingsport, Tennessee where it joins the South Fork of the Holston River to form the Holston River. The Holston River flows about 80 km (50 mi) to the Cherokee Reservoir, and thence an additional 160 km (100 mi) to the Tennessee River.

The North Fork of the Holston River is a mountain stream with an unregulated flow ranging from 0 to 467 m^3/sec (0 to

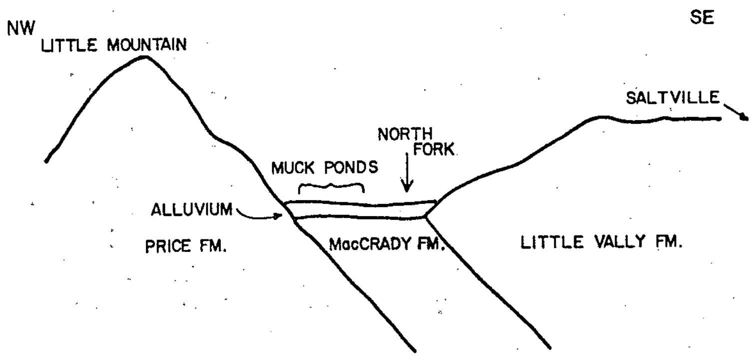

Figure 2-3. Generalized geologic cross section*.

* The cross section is perpendicular to the strike direction and the vertical exageration is approximately 2.5 times the horizontal distance.

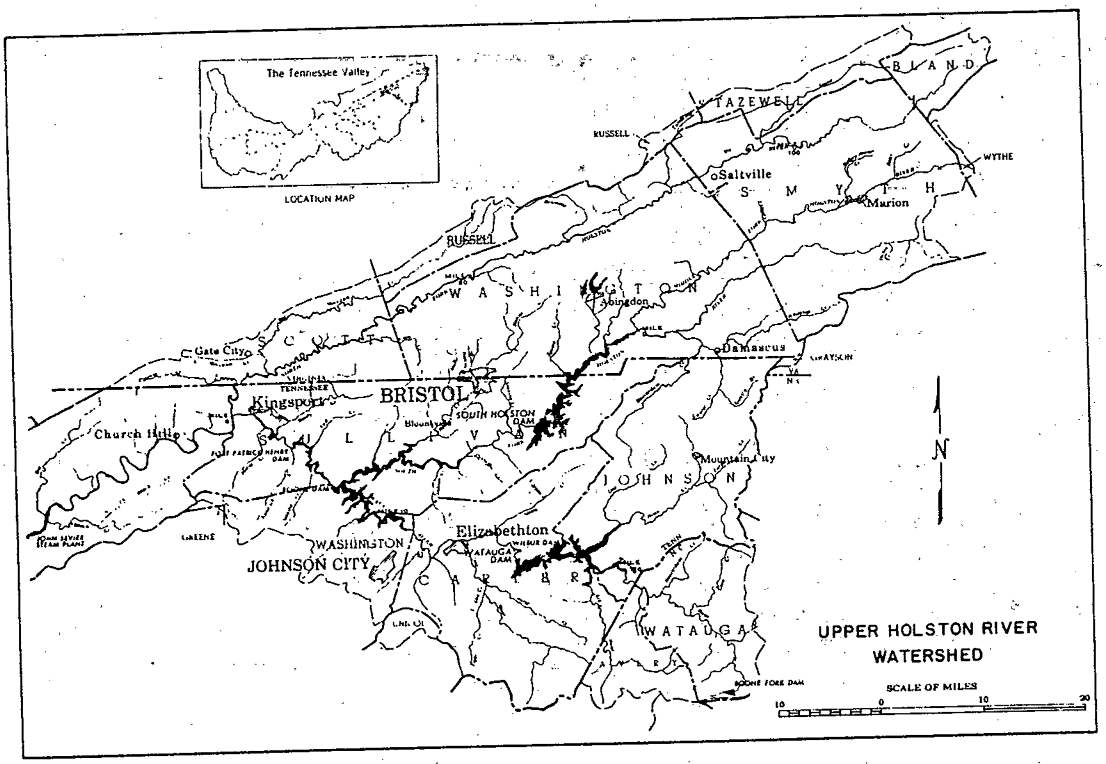

Figure 2-4. Upper Holston River watershed. [2-2]

16,500 ft^3/sec). Typical stream flow at Saltville is about 80 m^3/sec (300 ft^3/sec). Extensive pool and ripple areas are located in the river, and the riverbed is primarily composed of boulders and cobbles with submerged rock ledges. Figure 2-5 shows that the riverbed has been altered in the area which now houses two ponds used for disposal of Olin's liquid wastes. The River now flows to the southeast of Ponds 5 and 6 rather than through the area in which these waste ponds are located.

The two plant site areas causing environmental concern are the old chlorine plant site and Ponds 5 and 6. Since corrective action has only been implemented at the old chlorine plant site, this area will be emphasized.

Hydrogeological studies indicate that most of the ground water underlying the former chlorine plant area is the result of infiltration of precipitation. However, the western part of the chlorine plant area derives some ground water from the Robertson Branch Creek and some from precipitation falling on higher surfaces. Ground water has been found at the old chlorine plant site at depths from 4 to 6.4 m (13 to 21 ft). Hydraulic connections occur horizontally and vertically between the rock, alluvium, and fill. [2-4] The drinking water for the Town of Saltville is supplied by mountain springs located at higher elevations north of the plant site. These springs are capable of supplying 0.07 m^3/sec (1.5 mgd).

SITE OPERATION AND HISTORY

In 1748, saline brines were discovered in the vicinity of Saltville. Although salt production began in 1788, production was sporadic until the Mathieson Alkali Works acquired the property in Saltville in 1892. The first alkali product was produced in 1895 by Mathieson.

To capitalize on the raw materials of the area (e.g., rock salt and limestone deposits, as well as coal fields), Mathieson began to broaden their chemical product capability. A dry ice plant, the largest of its kind, was constructed in 1931. In 1951, the electrolytic chlorine and caustic soda plant was constructed by the Company, then called Mathieson Chemical Corporation. Mathieson merged with Olin Corporation in 1954, constructed a hydrazine plant, and began production of rocket fuel. The hydrazine plant, operated for the U.S. Air Force, was the last major addition to the Olin complex.

Due to economic and technical factors, Olin Corporation began closing their facility in Saltville in 1970 and completed the process by 1972. Olin had owned 3,000 ha (7,300 ac) in Smyth and Washington Counties and was the only major industry in the area. About 1,400 ha (3,500 ac) was donated to the State

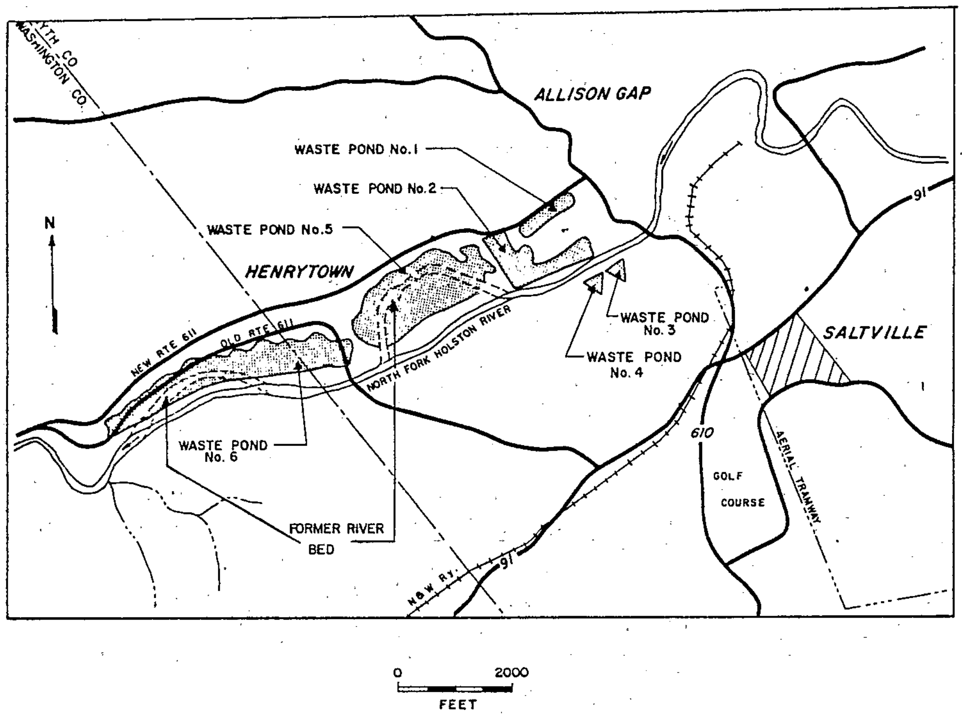

Figure 2-5. Location of former river bed through Waste Ponds 5 and 6. [2-3]

of Virginia as a game and timber reserve. About 1,400 ha (3,500 ac) within the corporate limits of Saltville were donated to the Town, including the plant site, building, and surrounding farm lands. In addition, mineral rights plus some money was awarded to the Town.

From July 4, 1895 until June 20, 1972, Olin Corporation and its predecessors (Mathieson Chemical Corporation and Mathieson Alkali Works) operated a chemical complex at Saltville. A list of principal products and manufacturing processes utilized by Olin at the Saltville complex is displayed in Figure 2-6. As shown in Figure 2-7, raw materials were converted to soda-alkali compounds via the Solvay process. Chlorine and caustic soda were produced by electrolysis from salt (see Figure 2-8). The Solvay process and chlorine-caustic process produced significant quantities of wastes. The Solvay process produced sodium chloride, calcium chloride, calcium carbonate, calcium hydroxide, and other solids as wastes. The chlorine-caustic process produced caustic soda, salt, and mercury as wastes. The dry ice, liquid carbon dioxide, and hydrazine processes did not produce wastewater with any significant contaminants.

The Saltville facility produced 0.1 m^3/sec (2 mgd) of waste containing 910,000 to 1,360,000 kg (1,000 to 1,500 tons) per day of calcium and sodium chlorides (salt), plus much smaller amounts of caustic agents, mercury, and other contaminants. The wastewater was discharged to large disposal ponds where the solids were settled and supernatant discharged to the North Fork. During the plant's operation, a total of six such ponds were used. Ponds 1 and 2 have since been filled and residences are located atop Pond 1. Ponds 3 and 4 were only temporary holding lagoons, and Ponds 5 and 6 exist to this day, although they are now dry.

POLLUTION

As a result of preparation of alkali and chlorine products, the North Fork has elevated levels of total dissolved solids (TDS) and mercury. During the

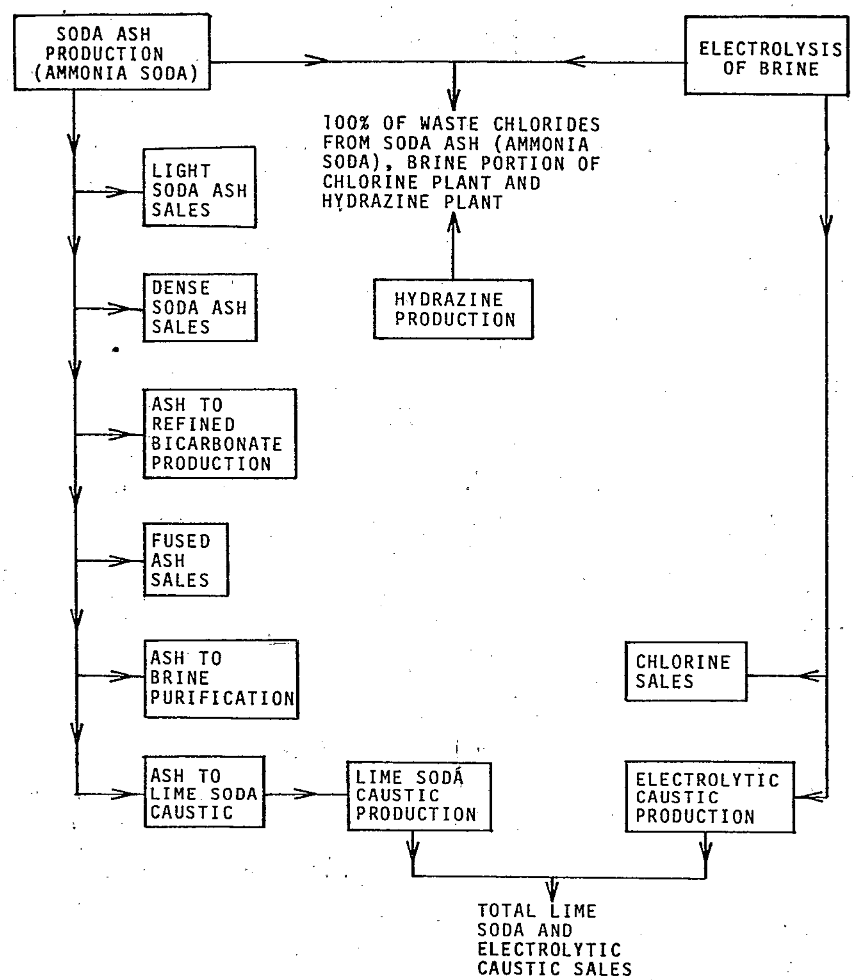

Figure 2-6. Process flow diagram for Olin alkali plant. [2-2]

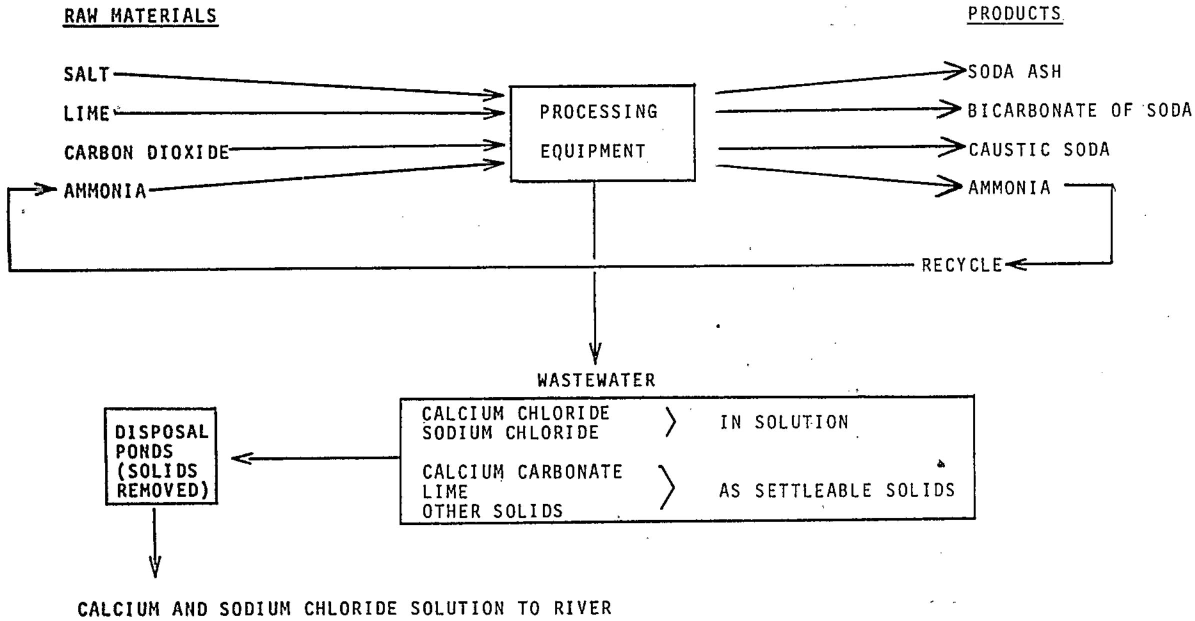

Figure 2-7. Soda-alkali production at Olin Saltville plant. [2-2]

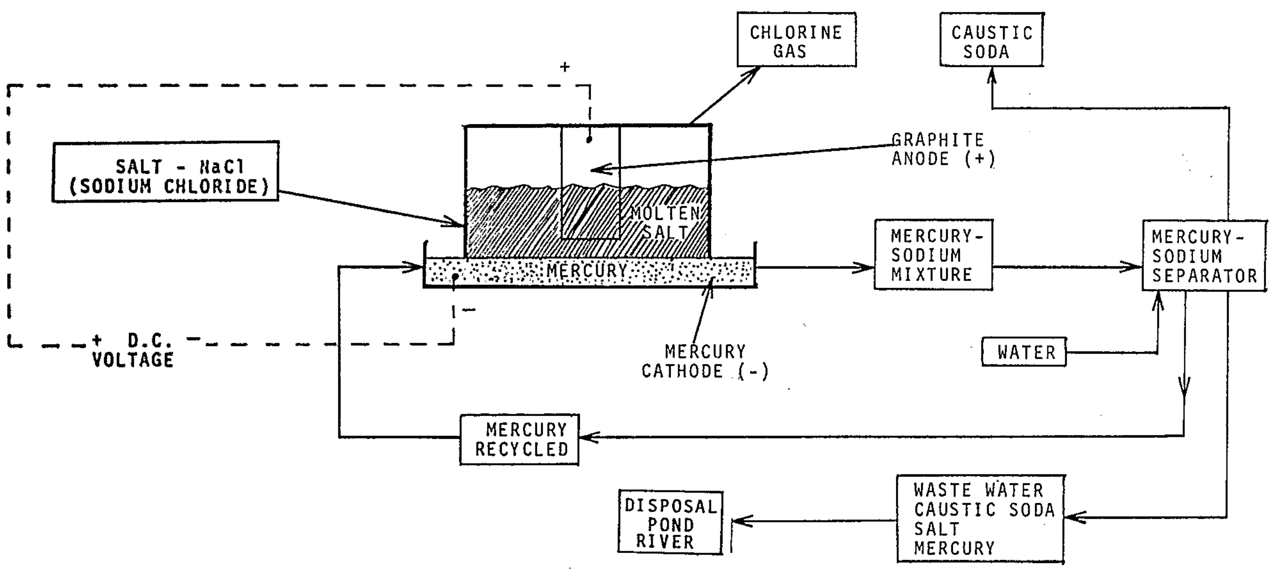

Figure 2-8. Chlorine-caustic production at Olin Saltville plant. [2-2]

plant's operation prior to 1969-70, the State Water Control Board regulated the chloride discharges and gave little attention to the amount of mercury discharged. Since the plant's closure, the 500 mg/l TDS standard for the North Fork is exceeded 60 percent of the time. However, no real health hazard is experienced from TDS loading and resident fish appear to have acclimated. Also, the river water is too brackish for use as a water supply and there is no demand for its use since ground water supplies are adequate.

Approximately 10 percent of the TDS concentration (as salt) in the North Fork is estimated to be the natural background level. Salt leakage from the brinefield is believed to have occurred for many centuries and could be considered to be a natural condition since the present Saltville flat was once a salt lake around which Pleistocene mammals gathered. It is probable that the mining operations of Olin and its predecessor aggravated the situation. However, saline flows could probably not be stopped since the near-surface geological formations are fragmented. The brinewell field contribution to TDS is not considered to be easily remedied. The TDS loading due to Ponds 5 and 6 is considered to be at least partially abateable.

In 1969, the Swedish scientists Jensen and Jernelov published the first findings on methylation and subsequent bio-accumulation of inorganic mercury in the environment. Their discovery focused attention upon the amount of mercury being discharged as waste. Virginia State Water Control Board water analysis of the North Fork indicated that the stream was seriously contaminated with mercury.

Beginning in 1951, Olin Corporation used mercury in an electrolytic chlorine process. The mercury-contaminated wastewater and process wastewater were recycled, disposed in the ponds, and/or discharged to the river. In 1970, tighter restrictions were placed on chlorine plants, as a result of Jensen and Jernelov's discovery of mercury methylation. Before regulation (1950 to 1970) an estimated 45 kg/day (100 lb/day) of mercury discharged to the North Fork via spills, runoff, and other pathways. After regulations were developed (1970 to 1972), Olin reduced losses to about 0.1 kg/day (0.25 lb/day) by recycling and tightening plant operations.

Olin officials had planned to redesign the plant and to further reduce mercury discharge to a minimum. However, Olin later decided to abandon the Saltville plant since the cost of repair and restoration was prohibitive. Olin closed the plant and donated its land to the State of Virginia and the Town of Saltville in 1972.

A 0.5 mg/kg (ppm) mercury level in fish was established by the Food and Drug Administration in Spring 1970. Since September 1970, the North Fork of the Holston River has been closed to fishing for eating purposes as a result of the mercury content in the fish. Game fishing is now allowed. The Virginia State Water Control Board annually monitors the mercury content in the fish and river sediment.

When it became evident that the natural dispersive processes would not eliminate the mercury problem and return the River to an acceptable quality, the State and Olin began to consider clean-up actions. A mass balance study of mercury input to the river conducted by Olin from October 1978 until November 1979 indicated an average mercury input of 45 g/day (0.10 lb/day). State samples taken during the same period indicated an input of 40 to 60 g/day (0.10 to 0.13 lb/day). [2-5] Mercury's physical property complicates the contamination process. Because of its weight mercury has the tendency to settle out and water does not act as a driving force. The higher than water density of mercury resulted in accumulative deposits of mercury in the riverbed from long-term, historical discharges. Abatement of mercury contamination of the river will thus require dredge removal or fixation of the riverbed mercury.

Even with a mercury input to the North Fork of 60 g/day or 22 kg/year (0.13 lb/day or 10 lb/year), the concentration of mercury in the flowing river probably never exceeds 1 ug/l (1 ppb) and rarely exceeds 0.2 ug/l (0.2 ppb). The mercury criterion for domestic water supply is 2.0 ppb and this level would probably never be exceeded. As further health protection, there are no public water supply intakes in the North Fork below Saltville, nor is there a need for public water intakes on the river. Thus, apart from human consumption of fish caught in the river, the mercury level in the water was not seen as presenting a health hazard.

The two site areas containing residual contamination and discharging mercury have been identified as Pond 5 and the old chlorine plant site. The only pollution source which has been assessed and which has received corrective actions is the chlorine plant site. Therefore, for purposes of clarity, the mercury contamination as associated with the chlorine plant will be discussed more than the problem associated with Pond 5.

Pond 5 was recently assessed by a consultant for Olin. The report revealed that 92 percent of the mercury, approximately 38,600 kg (85,000 lbs), in the pond was confined to the top 5.3 m (17.5 ft) of the solids comprising 612,000 m^3 (800,000 yd^3). The average concentration in the top 5.3 m (17.5 ft) of soils was about 13 mg/kg (13 ppm). Olin estimates that it will cost $25,000,000 to $30,000,000 to remove this material and dispose of it in a secure landfill. A water balance conducted on Ponds

5 and 6 indicated that 60 percent of the total water results from direct rainfall onto the pond. Ground water contributions are insignificant.

Approximately 100,000 kg (220,000 lb) of mercury has been estimated to be at the surface and subsurface of the demolished former chlorine plant site. The fill material contains the highest concentration of mercury and the alluvium contains the lowest concentration. Generally, soils in the western half of the building site contain the highest concentrations of mercury. Mercury beads, up to 1.5 mm (0.1 in.) in diameter, have been visible on the top surface of concrete structures. Mercury concentrations in the soil above and below the concrete were found to be less. Most of the mercury present at the site entered the subsurface during the years that the chlorine plant was in operation.

It appears that mercury percolated downward via gravity through pore spaces in the fill and alluvial materials at the chlorine plant site and along open bedding planes and joints in rock. It then collected in high concentrations in the subsurface where relatively tight materials such as concrete and tight rock formed barriers to further downward migration. Because of gravity and ground water movement, mercury could have spread laterally for short distances. However, it is believed that the lateral movement of elemental mercury at the site in the ground water is slight.

REMEDIAL ACTION

When it was determined that the natural dispersion of mercury would be slow, with centuries elapsing before the river ecosystem recovered completely, Olin Corporation and the State of Virginia began taking the first steps to correct the problem.

A Saltville Task Force was established to study the level of mercury, evaluate the problem, and advise Olin on acceptable measures to remedy the problem. Members of the Task Force represent the U.S. Environmental Protection Agency, State of Virginia Water Control Board, the State of Tennessee Department of Public Health, and the Tennessee Valley Authority.

The former chlorine plant site continued to discharge mercury into the river after its closure in 1972 through residual materials and deposits at the plant site. Olin's consultants studied the movement of elemental mercury at the chlorine plant site (1) through the soil and rock, (2) in the ground water, and (3) by soil movement through erosion.

The potential for mercury pollution of the river through erosion was deemed to be greater than through ground water seepage from the area to the river. The fill material at the former plant site has higher mercury concentrations than the ground water. This mercury could be deposited in the river by sheet flow runoff, especially from the steep river banks at times of heavy rainfall. A flood in April 1977 undercut the river bank in front of the former chlorine plant site. The amount of mercury deposited into the river by erosion and movement of particulate matter is believed to have been significant. It is also probable that stream bank erosion at the site during high river flows in the mid-1970's carried more mercury into the River and contributed to the noticed increase in mercury contents in fish and sediment.

The corrective action completed in 1979 included implementation of erosion control measures along the river bank to prevent further discharge of mercury. This was the first corrective project Olin undertook in conjunction with the Task Force. Olin Corporation contracted W-L Construction of Chilhowie, Virginia to implement the erosion control project. The U.S. Army Corps of Engineers and the Virginia Water Control Board reviewed the plans for the project. The detailed engineering work was done by a consulting firm from Chicago, Illinois.

Approximately $400,000 in costs were incurred by Olin to prevent erosion of the river bank in the area of the chlorine plant. The project (see Figure 2-9) began in October 1978 and was completed by April 1979. The corrective measures to reduce mercury concentrations in the North Fork included the following:

1. Drainage diversion measures. Revisions to prevent the possibility of Robertson Branch Creek overflowing onto the chlorine plant site consisted of the following:

   a. The road across the Branch Creek serving Tri-Cities Dry Ice was modified to include a 7.6 m (25 ft) wide by 3 m (10 ft) high arch structure to allow higher flows to pass.

   b. An earthen berm was constructed from the above mentioned road along the chlorine plant site to the double-barreled culvert.

   c. An overflow channel was constructed on top of the double barreled culvert. A 2:1 slope was maintained in the overflow channel by removing previous railroad tracks, and by applying sand, filter material, and riprap on the slope.

2. Sealing off the plant site from the North Fork (see Figure 2-10). The slope of the chlorine plant site facing the river was regraded to a 2:1 incline. Soil and debris which noticeably contained mercury deposits were removed from the slope and placed back away from the North Fork on the former chlorine plant site. Sand

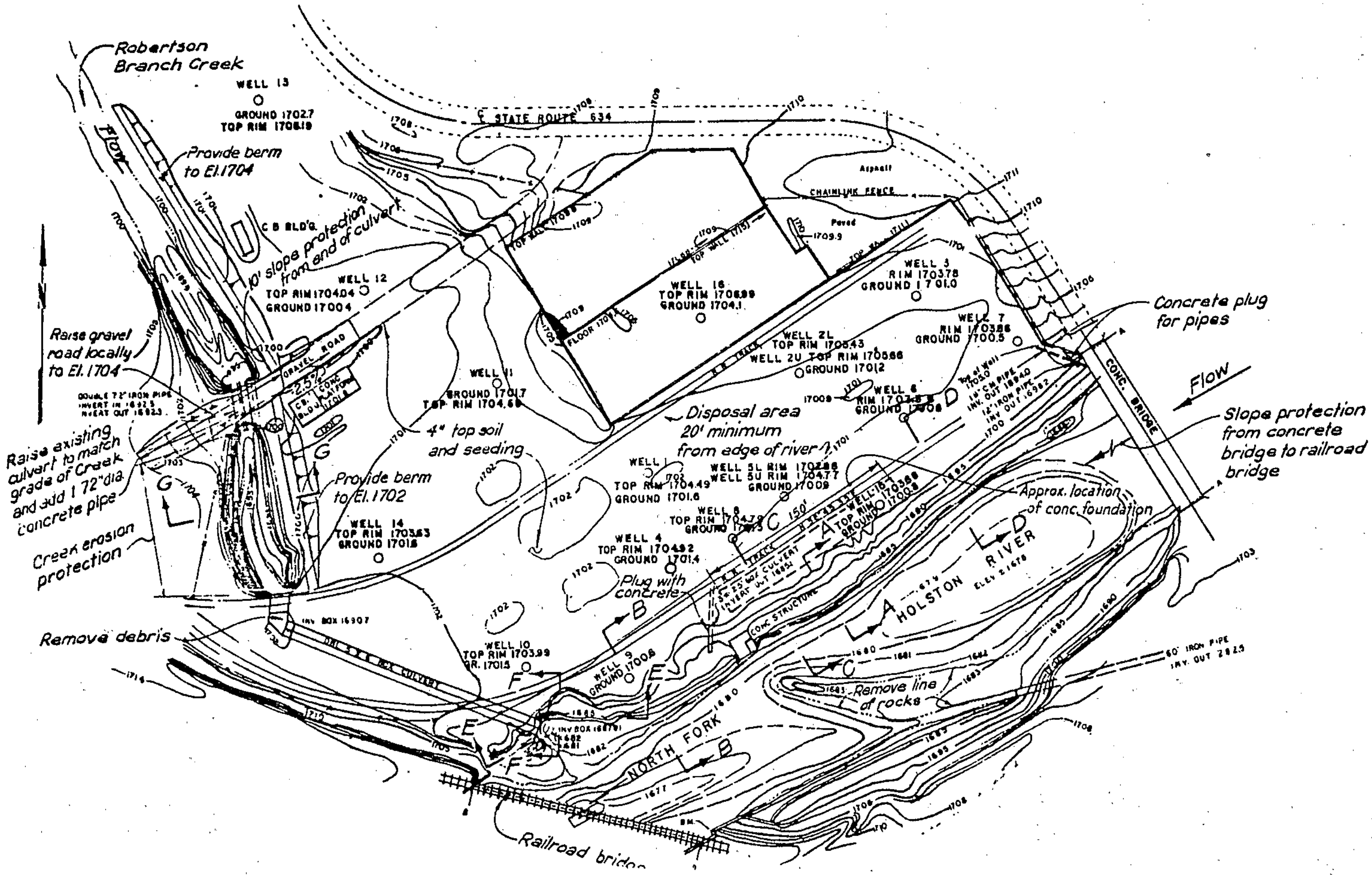

Figure 2-9. Erosion control measures at chlorine plant site. [2-6]

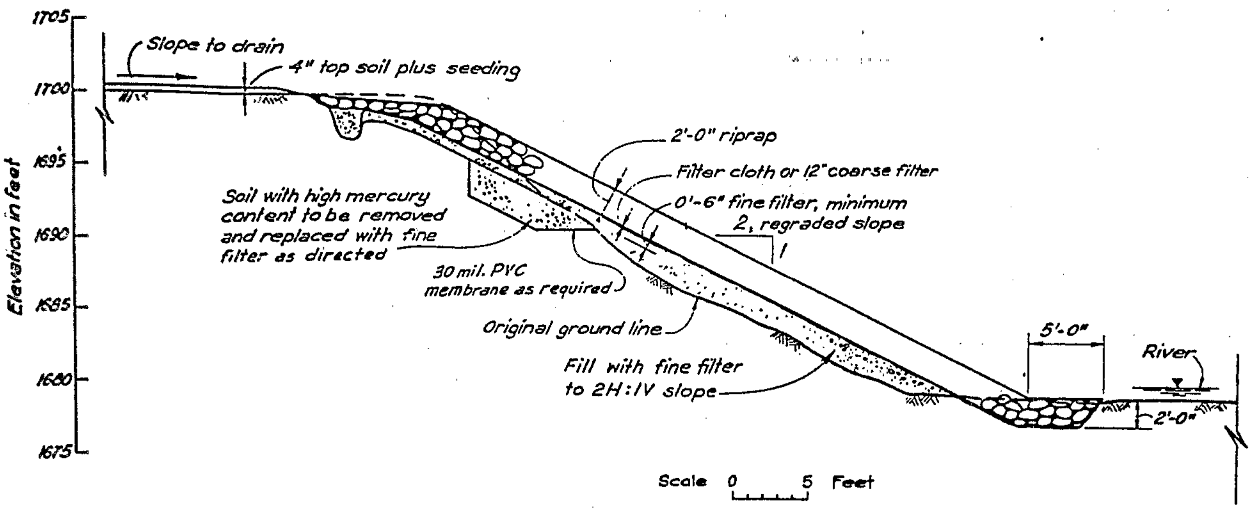

Figure 2-10. Construction details for sealing North Fork riverbank. [2-6]

was applied to the slope, at a thickness of from 5 cm to 15 cm (2 to 6 in.). A 0.8 mm (30 mil) polyvinylchloride (PVC) mesh filter was applied over the sand to hold it in place. Finally, riprap was applied on the slope.

3. Removal and plugging of drainage pipes from the area. Two drain pipes and a rectangular concrete drain were located during the excavation and regraded. These drain structures were moved back a distance from the North Fork and plugged.

4. Prevention of precipitation infiltration. A 10 cm (4 in.) layer of topsoil was used as cover material for the chlorine plant site. The area was then seeded.

The above measures were implemented as erosion control measures and are considered effective to that end. It is hoped that these measures will prevent the migration of mercury from the chlorine plant area during flooding and high stream flows. Entrance of water due to surface runoff from the nearby hills and overflow of Robertson Branch Creek, likewise should be prevented by the surface diversion measures installed.

It is difficult to accurately determine the extent of mercury contamination at the site and in the river and fish. Fish data taken since plant closure appear random since statistically the change in mercury concentration over time can be equally represented by a line with a positive, negative, or flat slope. [2-5]

Figures 2-11 and 2-12 present mercury concentrations of fish and sediment before and after the erosion control activity was implemented at the chlorine plant site. The sampling station identification number increases with distance downstream from the site. Sampling Station B1 is located 8 km (5 mi) downstream from the former Olin plant site. Sampling Station B6 is 119 km (74 mi) downstream of the Olin site. Figure 2-11 illustrates the mean mercury content of fish in July 1978 (prior to remedial action) and July 1979 (after remedial action). Likewise, Figure 2-12 indicates the mean mercury content of the sediment in the North Fork in July 1978 and July 1979. From viewing Figures 2-11 and 2-12, it is difficult to determine if further discharge of mercury has been prevented. Because of the behavior of mercury, lodgement of mercury on the river floor may be creating a random data appearance. Time will permit the collection of a larger data base for mercury concentrations in fish and sediment. Perhaps then, a site-specific accurate assessment of mercury mobility and transport mechanisms can be made, as well as a determination of whether further mercury discharges from the chlorine plant site are continuing.

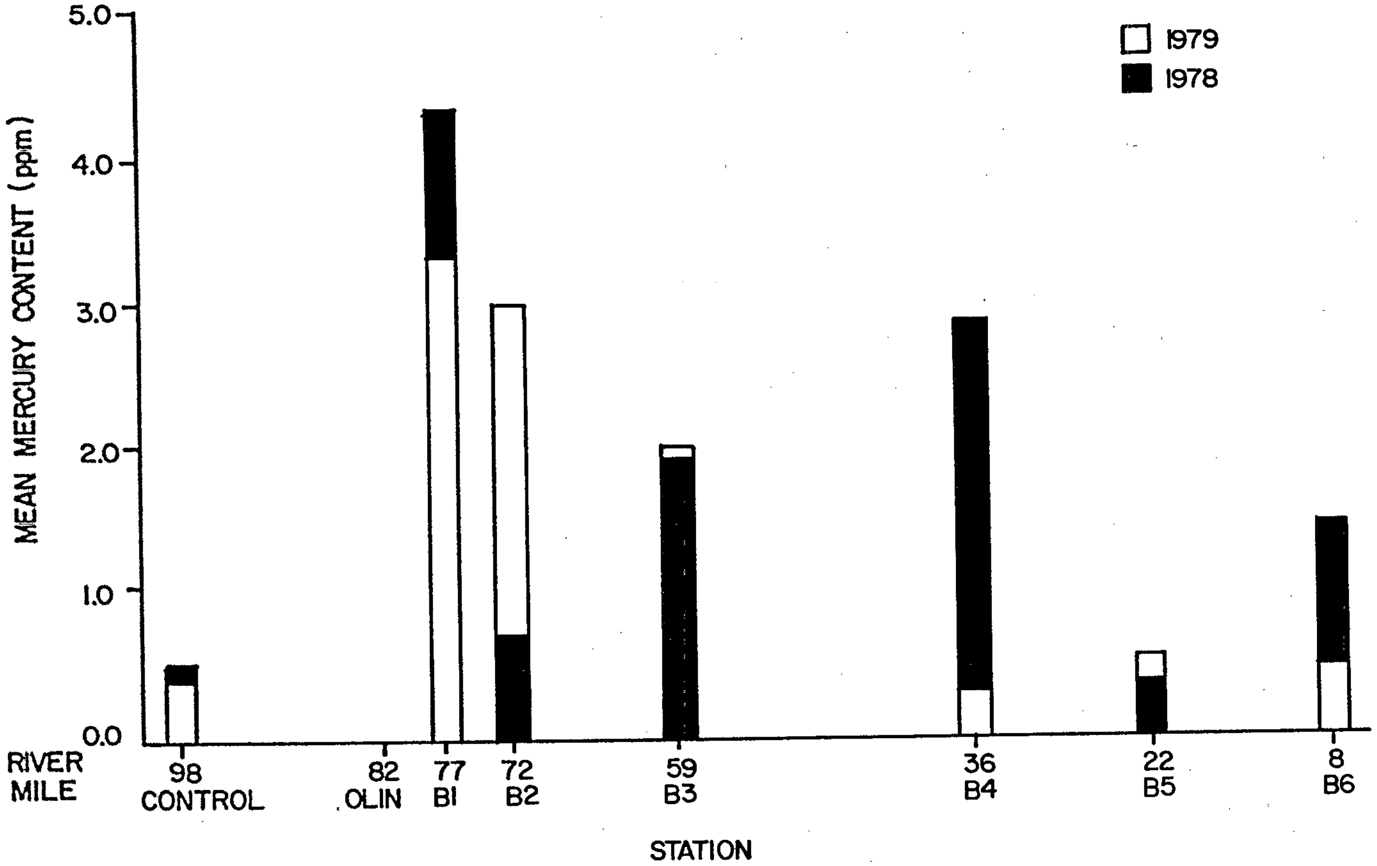

Figure 2-11. Mean mercury content of the sediment at the control and affected stations on the Holston River, July 1978 and July 1979. [2-7]

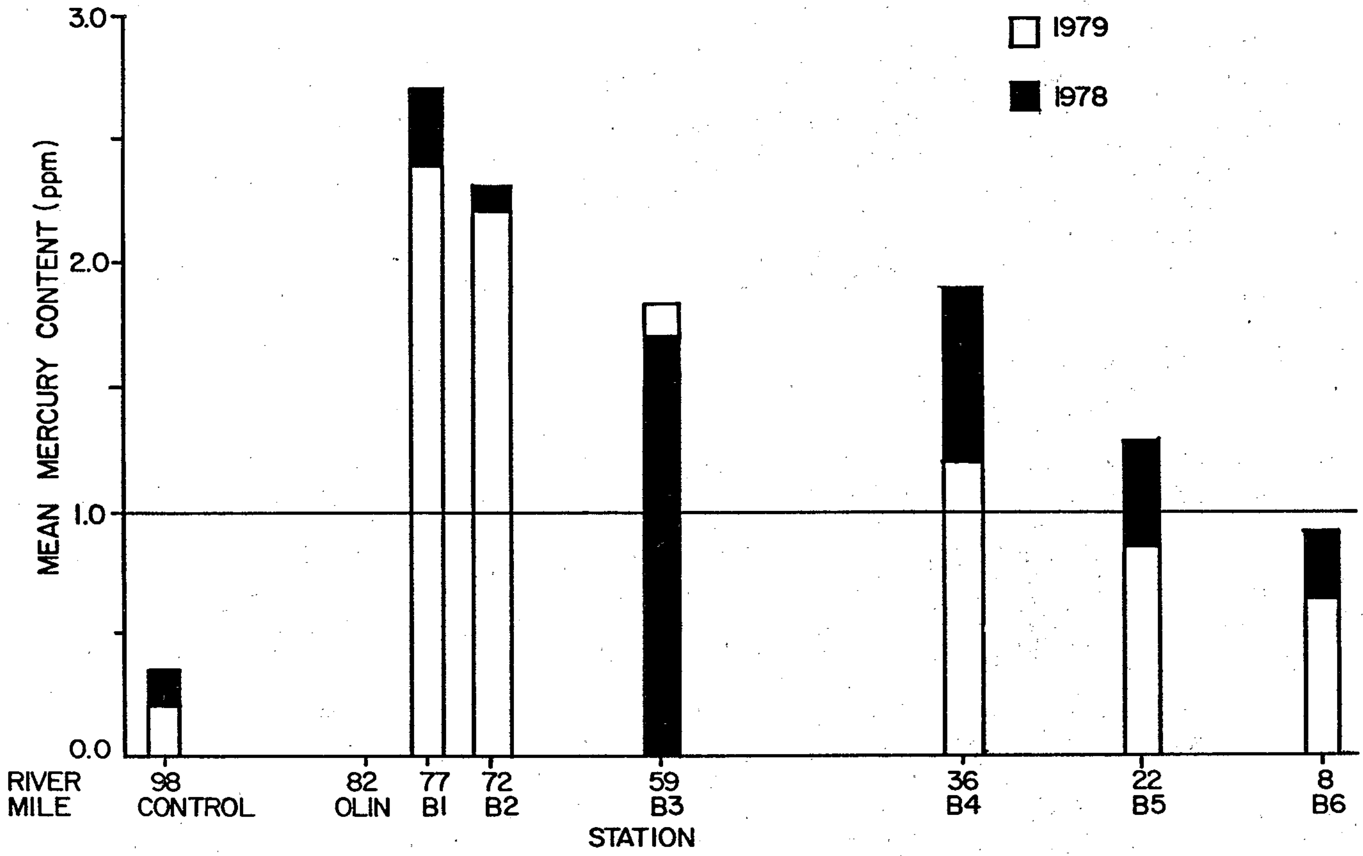

Figure 2-12. Mean mercury content of the fish at the control and affected stations on the Holston River July 1978 and July 1979. [2-7]

Concurrently, Olin's consultants have been collecting data and investigating methods of corrective action at the disposal ponds. The six ponds constructed over the years by the site operators were operated in accordance with standard operating practices of the day. While four of the six have reverted to a natural state, two of the ponds remain active pollution sources. Ponds 5 and 6 are sources of total dissolved solids (mainly calcium and sodium chloride) pollution; Pond 5 is also a source of mercury pollution.

Pond 5, which covers 29 ha (72 ac) contains 5 million m^3 (7 million yd^3) of waste. No final decision has been made on abating the mercury problem associated with this pond. The soil under the pond consists of sandy, cobbled material, and thus containment of leachate from the bottom of this pond would be difficult. As an alternative surface sealing has been proposed to prevent further intrusion of rainwater. Such sealing would be less expensive to install and although it would not prevent any further leaching, it would minimize the amount of future leachate discharges.

CONCLUSION

When the chlorine plant at the Olin complex ceased operation and was demolished, it was anticipated that the environmental problem associated with mercury contamination of the fish in the North Fork of the Holston River would gradually diminish. However, mercury concentrations in fish have fluctuated and actually appear to have increased in 1977. This increase correlated with a reduction in dissolved solids and chlorides in the North Fork. Likewise, river sediment values fluctuated and a linear decrease was not noted for some 80 km (50 mi) downstream. It was theorized that the increases in mercury content in the fish was the result of changes in the stream's chemistry after the plant closure. This increase has since subsided, but some mercury discharge has continued and the stream remains contaminated. No reduction in mercury concentrations has been substantiated in the eight years since closure.

In mid-1976, the State of Virginia and Olin Corporation began studying the problem. The State of Tennessee also became involved with the assessment since the North Fork of the Holston River empties into the Tennessee River. There is evidence that the contamination extends down the river to the TVA Cherokee Reservoir, 161 km (100 mi) from Saltville, Virginia.

Delay in correcting the mercury contamination problem has been the result of several factors, one of which would be the time consuming environmental and engineering studies to rationally analyze the problem and to formulate cost effective corrective measures that would have a reasonable chance of success.

Presently, only a small part of the environmental problems associated with the previous operations at the chemical complex has been corrected. The completed corrective action includes erosion control measures implemented at the former chlorine plant site. These measures appear to be successful in limiting further mercury contamination from the chlorine plant site from entering the North Fork, according to representatives from both the Virginia State Water Control Board and Olin Corporation.

Olin believes the largest potential source of mercury discharge to the river has been corrected. They maintain that current discharges of TDS and mercury are between 0 and 20 percent of levels discharged during the years immediately before and after plant closure. Thus, Olin officials believe a large portion of the overall environmental problems associated with the chemical complex were mitigated by the plant closure and subsequent remedial actions. [2-5] Although a significant amount of effort and money has been expended, the U.S. EPA and Virginia State Water Control Board believe that correction of environmental problems from the site is only beginning.

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2-6 Topographic Survey for Olin Corporation by Hart and Bell. August 1977.

2-7 Turner, C.S. Draft, Mercury in Fish and Sediment of the North Fork of the Holston River, 1978 and 1979. Virginia State Water Quality Board, Bureau of Surveillance and Field Studies, Division of Ecological Studies. 1980.

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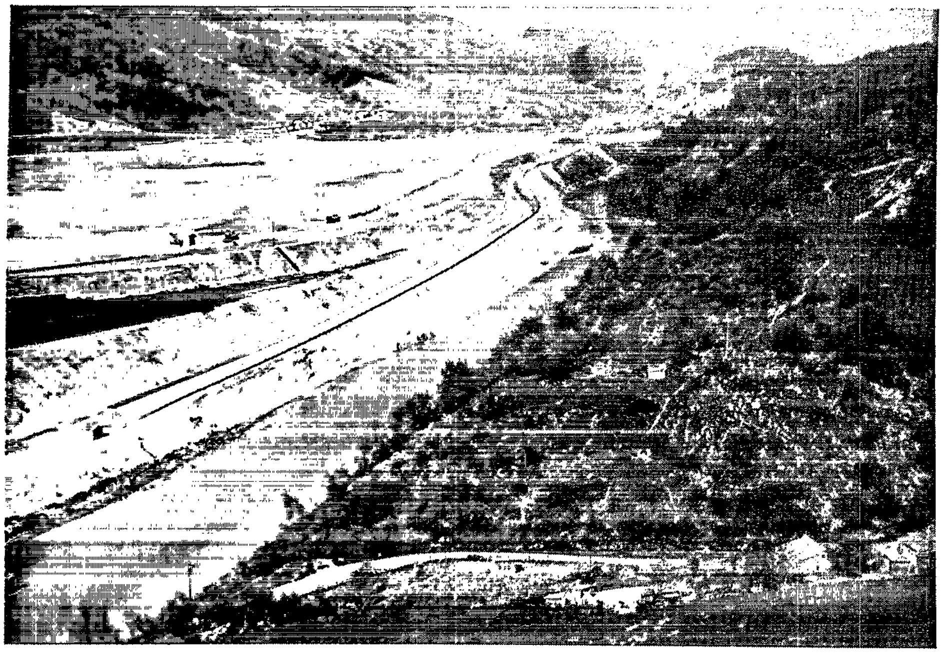
2-12 Personal communication with C.C. Norris, Olin Chemicals Group. Saltville, Virginia. June 6, 1980.

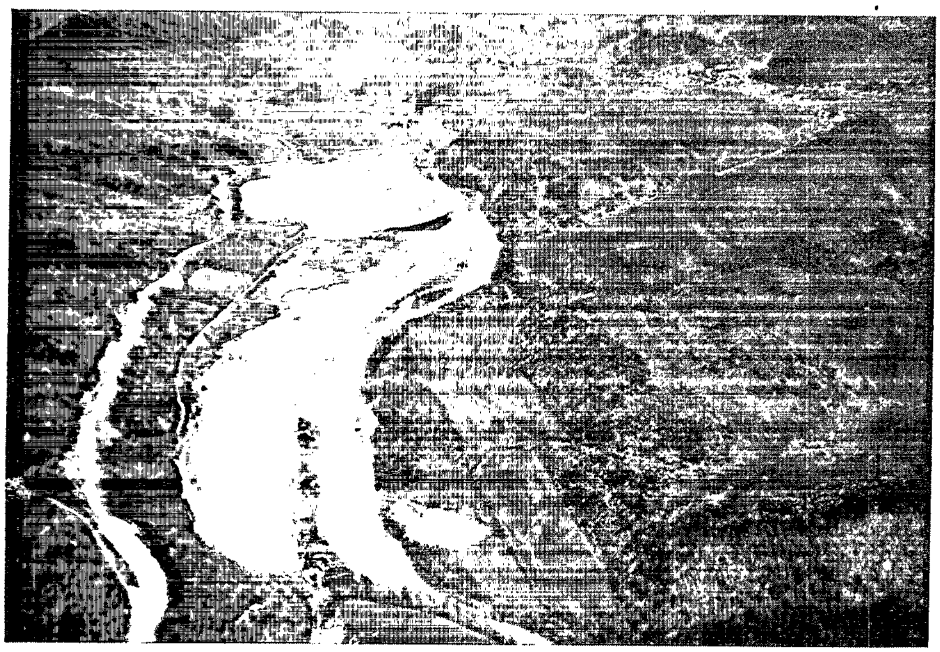
2-13 Personal communication with Frank E. Lewis, Mayor of Saltville, Saltville, Virginia. June 6, 1980.

APPENDIX 2-1

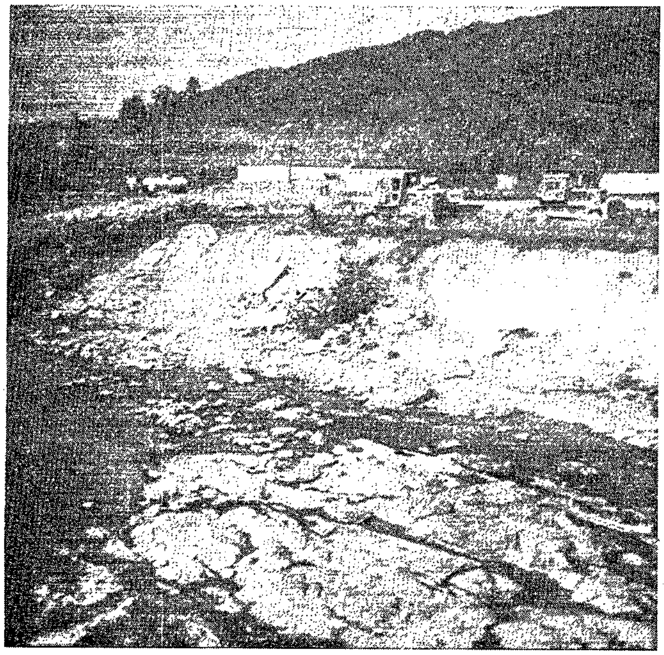
SITE A PHOTOGRAPHS

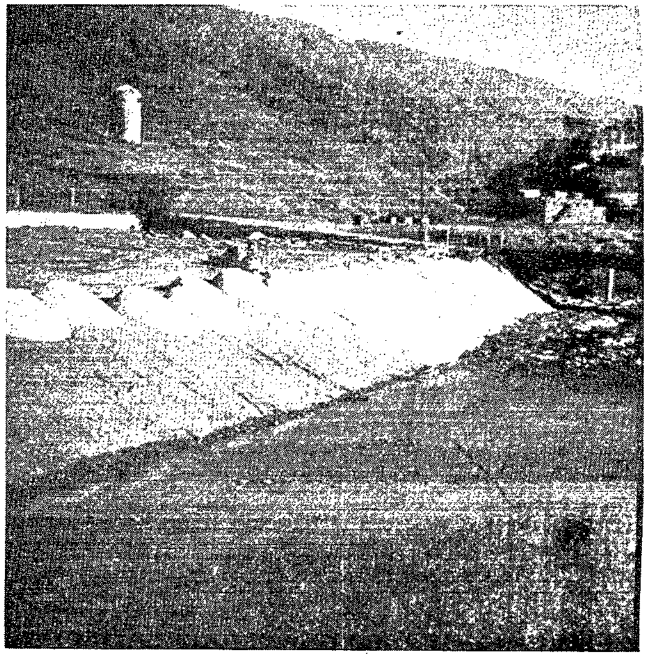


View of Olin Corporation at Saltville while it was still oerpational. Plant facilities are located in the upper right corner. Pond 5 is in the center and left portions of photo. The North Fork of Holston River borders the pond.

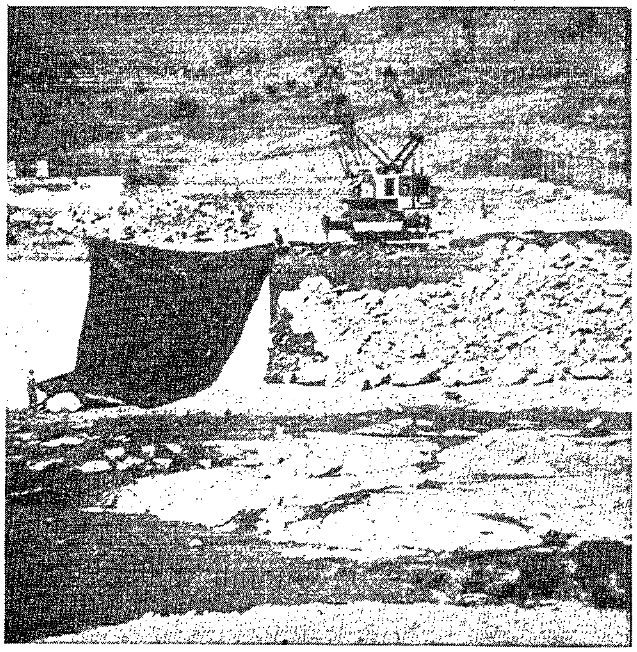


Overview of Olin Corporation at Saltville. Town of Saltville in upper right corner of photo. Olin plant facilities with Ponds 5 and 6 are located in the central portion of the photo.

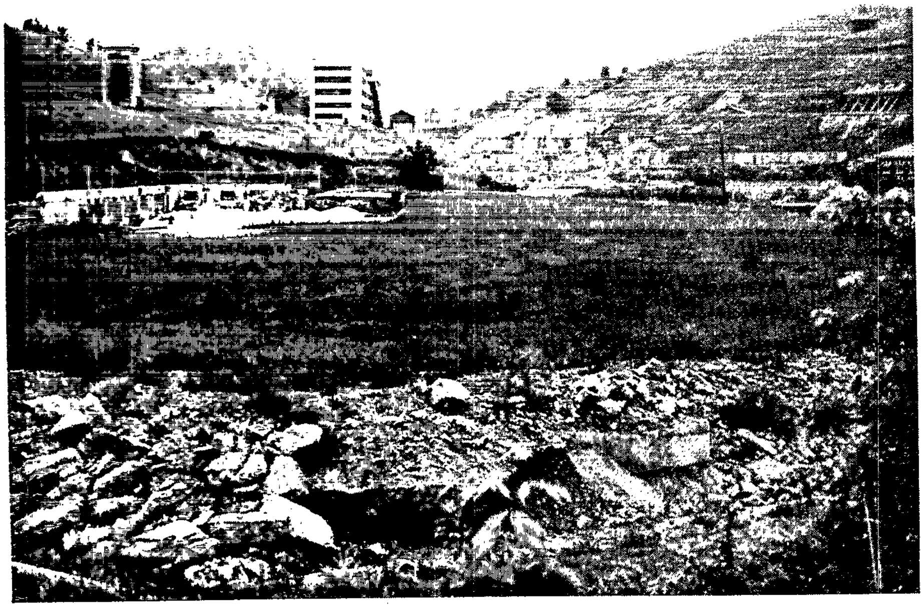




Appearance of river bank bordering chlorine plant site before and after sloping and sand application.



Application of plastic liner and riprap to resloped, sanded embankment of chlorine plant site.



Appearance of chlorine plant site after remedial action.

SECTION 3

SITE B
FIRESTONE TIRE AND RUBBER COMPANY
POTTSTOWN, PENNSYLVANIA

INTRODUCTION

In 1942 Jacobs Aircraft and Engine Company operated a machine shop for the production of aircraft engines in Pottstown, Pennsylvania. During this time, they disposed of cutting oils and metal filings in lagoons on their site. Firestone Tire and Rubber Company purchased the Jacobs site in Pottstown in 1945. Since that time, they have landfilled tires, inert cloth and rubber, pigments, zinc oxide, sulfur dioxide scrubber wastes, rubber flashing, and PVC sludge resins at the site. Iron, manganese, aluminum, sulfates, and chlorides originating from the landfill and lagoons on the site have polluted the ground and surface water in the area.

To remedy these water quality problems, Firestone has established a ground water recovery system of wells which purge the ground water near the lagoons and landfill so that no off-site migration of the contaminants occurs. The amounts of contaminants in the ground water and surface water are now within health standards as the Company continues to monitor the water quality in the area.

SITE DESCRIPTION

The Pottstown Plant of Firestone Tire and Rubber Company is located in southeastern Pennsylvania approximately 50 km (30 mi) northeast of Philadelphia in Montgomery County. The site occupies 106 ha (263 ac) within a meander loop of the Schuylkill River which eventually flows to the Delaware River. Pottstown, a community of over 20,000 people, lies a few kilometers (miles) upstream from the Firestone Plant. Residents in the area use the ground water for drinking water.

Pottstown receives about 110 cm (43 in.) of precipitation and 81 cm (32 in.) of snow per year. No frost can be expected from early April to late October. The winds average 15 km/hr (9.3 mph) from the west. The temperature averages about 10°C (51°F) year round with a summer average of about 22°C (72°F) and a winter average of about -3°C (26°F).

Firestone's old landfill area is located 45 to 90 m (150 to 300 ft) from the Schuylkill River. Both the new landfill area and the new lagoons lie about 200 m (600 ft) from the Schuylkill River (see Figures 3-1 and 3-2). The Schuylkill River is 0.6 to 1.2 m (2 to 4 ft) deep and 15 to 30 m (50 to 100 ft) wide (depending on seasonal variations) at the Firestone site. The river is 33 m (110 ft) above sea level and the landfill is 9 m (30 ft) deep. The river's 100 year frequency flood raises its level 9 m (30 ft) which would flood the bottom of the landfill. This has occurred three times in recent years. The site is fairly flat with a small valley that will be filled in with the expansion of the old landfill. The old landfill itself is flat across the top with steeply sloped sides.

The subsurface consists of two distinct materials. Alluvium, 6 to 7.5 m (20 to 25 ft) thick, lies at the surface and consists of thin layers of silt, sand, and gravel. The water table levels in this material correlate closely with river stages. There is little hydraulic gradient in this, the upper, or shallow flow system. The landfill and lagoons lie in this material. Underlying the alluvium are the Lockatong Formation, a mudstone and shale, and the Brunswick Formation, a shale, siltstone, and sandstone. The bedrock is not horizontal but dips approximately 30 degrees to the southeast (see Figure 3-3 and 3-4). Ground water in this, the lower or deep flow system, occurs along joints and bedding planes of the Brunswick Formation. The deep wells used for process water and potable water extend down into this system. There is some communication or recharge from the shallow to the deep ground water. Therefore, the Schuylkill River, the alluvium aquifer, and the bedrock aquifer are not independent of one another.

The area around the Firestone site is hilly and well drained. Elevations range from 33 m (110 ft) to over 90 m (300 ft) as seen in Figure 3-4. The vegetation at the Firestone site consists of grasses and some hardwood trees. The trees grow along the river banks and in the small valley. Native grasses have been planted on the landfill and other disturbed areas.

SITE OPERATION AND HISTORY

In 1942, Jacobs Aircraft Engine Company operated a machine shop and defense plant for the production of aircraft engines as part of the war effort. Cutting oils, metal filings, and other wastes were placed in an open dump on the site. Firestone Tire and Rubber Company bought the plant in 1945 and began tire production soon afterwards. They continued the use of the open dump through the early 1960's converting it to a landfill accepting vinyl resins, factory trash, and rubber tires. The landfill was originally 5.3 ha (13 ac) in size. Six earthen lagoons were also used for PVC wastes. Six deep wells were used in the early 1960's to supply water for process uses.

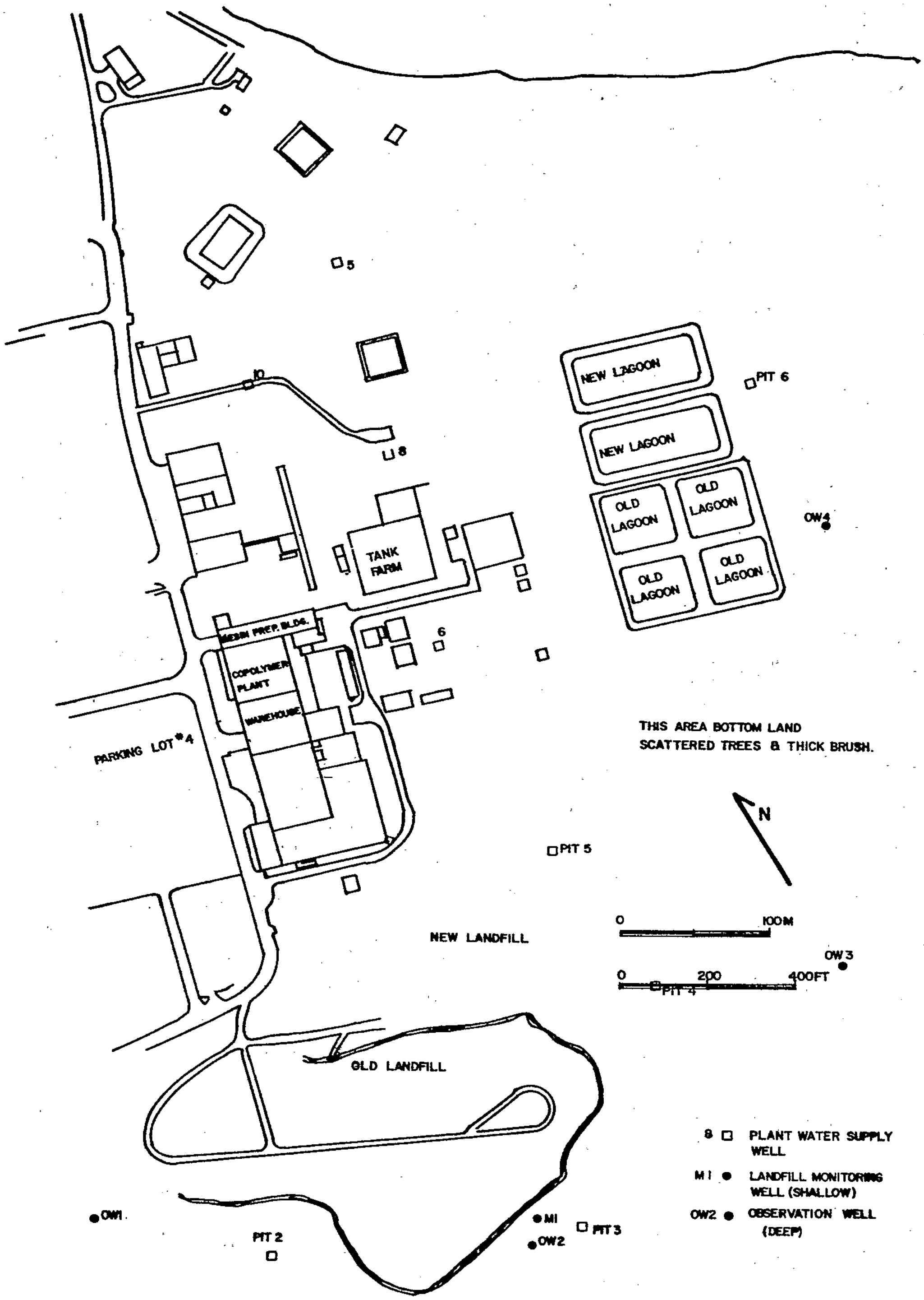


Figure 3-1. Partial map of the Firestone plant showing some wells and pits used for remedial action. [3-1]

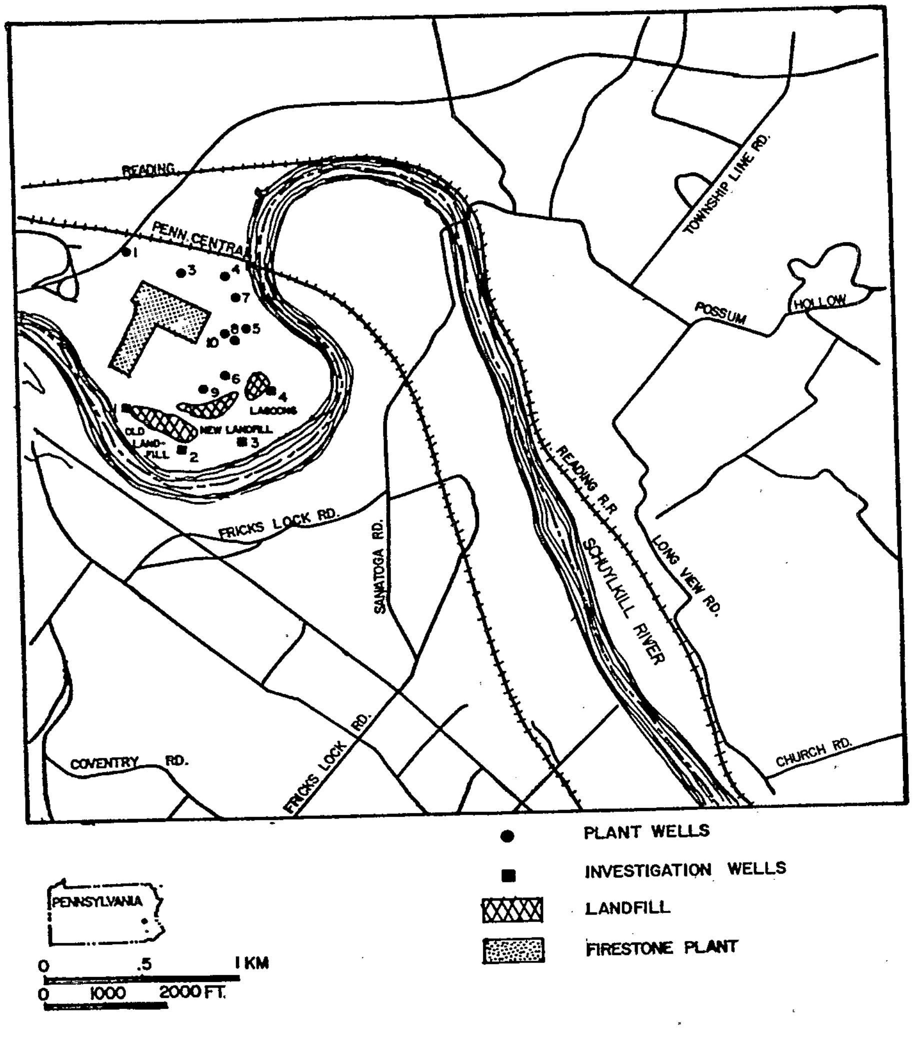


Figure 3-2. Location map of Firestone plant with remedial action wells.

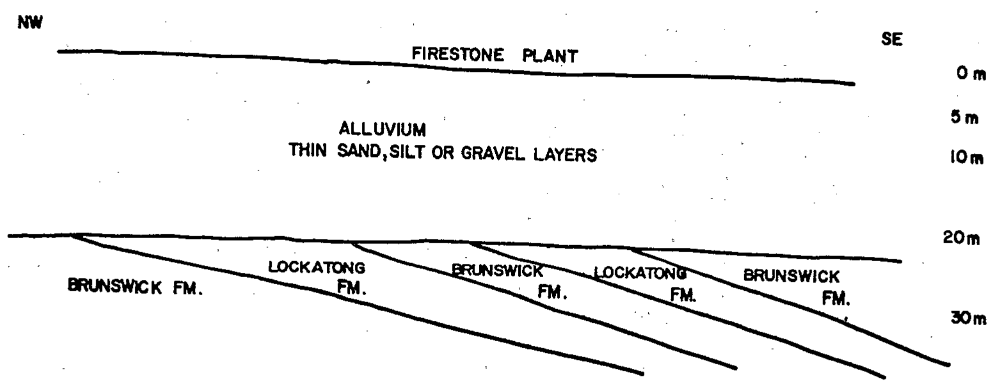


Figure 3-3. Rough geologic cross section of the material underlying the Firestone plant.

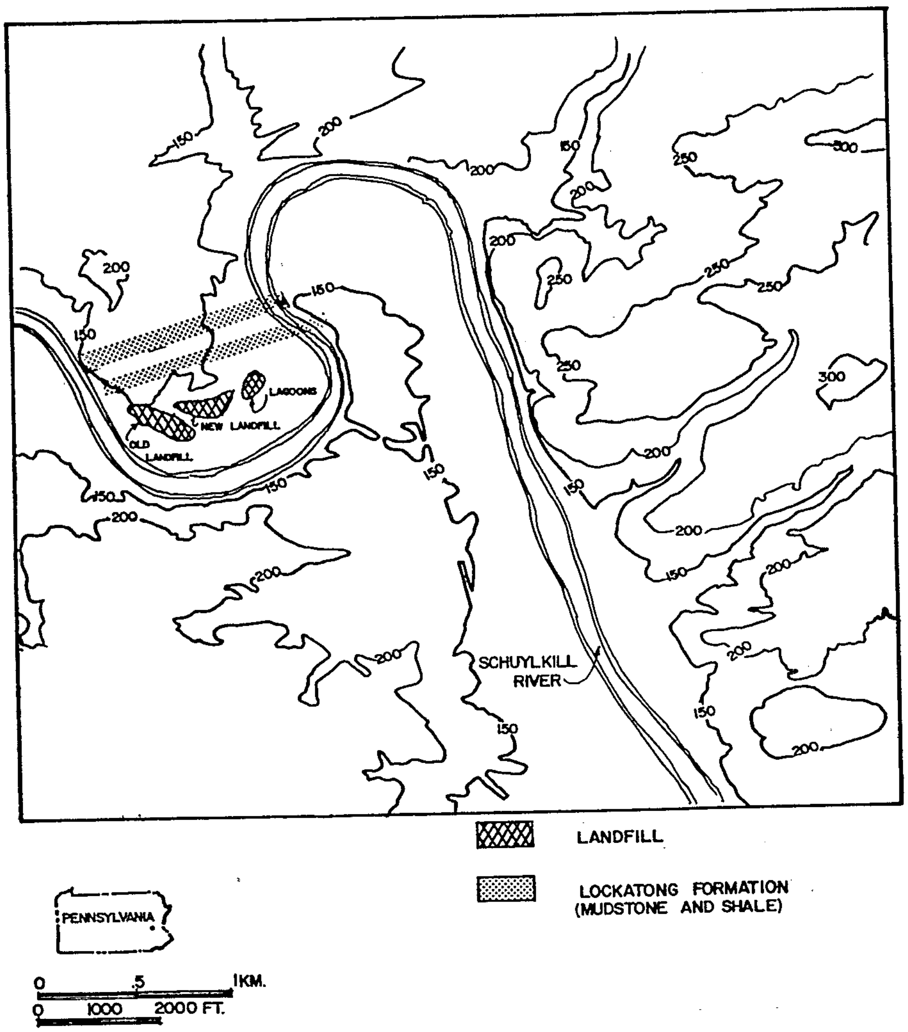


Figure 3-4. Location and partial geologic map for Firestone's Pottstown, Pennsylvania plant. [3-2]

Currently, Firestone operates a tire manufacturing plant, a chemical plant, and a sheeting plant which produces plastic resins, film, and sheeting products. They have proceeded with plans to close their tire plant. However, the chemical plants will remain in operation. Before the tire plant was closed, Firestone employed nearly 2,400 people, and produced 450,000 kg (1 million lbs) of finished tires per day. Both the number of employees and the amount of tires produced declined as closure activities continued. The chemical plant employs 450 people and the film and sheeting plant 250 people.

Both the tire and the chemical plants contributed to the landfill. In early 1971, an average of 30 metric tons (33 tons) of waste was landfilled per day; the majority of which was factory trash and paper. The following is a list of typical landfill refuse:

- Tires
- Paper
- Carbon black
- Polyethylene
- Wastewater treatment sludge
- Metal banding and strappings
- Wooden pallets
- Coagulated butadiene/styrene latex wastes
- Miscellaneous compounding agents or dust from clean-up activities (including sulfur and zinc oxides)
- Inert cloth and rubber
- Rubber flashing
- Oily rags
- Polyvinyl chloride (PVC) film
- Clay
- Talc
- Boiler fly ash
- Synthetic polymer fabric
- Oil/water emulsions
- Sulfur dioxide sludge
- Floor and roadway sweepings
- Fiber drums
- Lagoon wastes (including calcium carbonate, calcium hydroxide, and PVC resin)

Two lagoons are now used by the chemical plant. Both are rubber-lined and used only during emergencies. Wastewater is the only material added to the lagoon.

POLLUTION

Initially, the landfill and lagoon operations were considered environmentally adequate by the Pennsylvania Department of Environmental Resources. However, subsequent monitoring of wells and the Schuylkill River indicated contamination. Contaminants detected in the ground water in 1972 from monitoring wells placed around the landfill included iron (185 ppm), manganese (20 ppm), aluminum (10 ppm), and sulfates (140 ppm). Because of the interconnection of the two aquifers as well as the Schuylkill River, all three water bodies were threatened by the pollution.

The landfill was accepting nearly 27 metric tons (30 tons) of refuse per day in 1970 when Firestone applied for a new permit to operate a sanitary landfill. The permit was approved in July 1971, but not actually issued until August 1973 due to permit infractions and revisions. It was the first industrial land disposal permit issued by the State's Division of Solid Waste Management.

Firestone received a variance for a pilot plant process to remove sulfur dioxide and fly ash from their boiler stacks. They also received permission to landfill the wastes from the sulfur dioxide scrubber system in late 1973. Wastes from the scrubber process included calcium sulfite dihydrate, lime residues, fly ash, and sodium sulfate. The sludge was mixed with dirt and landfilled. Use of the scrubber system began in February 1975 as an experimental one-year operation in cooperation with the State. A permit for continued operation of the scrubber processing and disposal facility was granted in September 1977.

REMEDIAL ACTION

In early 1974, the Pennsylvania Bureau of Water Quality Management ordered that use of the six lagoons be discontinued. Two of the lagoons were excavated and one lined lagoon was installed in their combined locations. A second lined lagoon was installed alongside in virgin ground. These new lagoons were lined with multi-layered rubber liners developed by Firestone. The other four lagoons were filled during this time and a solids removal system was constructed upstream. The four lagoons were then discontinued. Currently, solids which are removed upstream go directly to the landfill and the lined lagoons are used only in emergencies. The new lagoons lie in a one-hundred year flood area but otherwise there is no discharge and, therefore, they do not affect the ground water.

In 1974 Firestone sought permission to expand their existing landfill, but were first required to install a leachate control system since lining the expanded landfill to isolate it from the ground water flow system was determined to be more expensive than flow manipulation. Also, it would be impractical to attempt to line the existing landfill. Therefore, Firestone began a ground watering recovery system consisting of 14 wells located as shown in Figures 3-1 and 3-2. Some of the extracted water would be used for processing and potable uses.

Three wells, used for potable water, draw a total of 0.01 m^3/sec (150 gal/minute) and are 60 m to 120 m (200 to 400 ft) deep. Five wells are used for process water which is deionized previous to use in the polymerization process. These wells draw 0.006 to 0.01 m^3/sec (100 to 200 gal/minute) each. The five wells form a large zone of depression beneath the seepage lagoons and the landfill. Recharge from the alluvium aquifer is drawn to this large zone of depression. Therefore, the pollutants entering the shallow flow system (alluvium aquifer) are similarly drawn down and do not flow to the Schuylkill River. Water from the Schuylkill River enters the alluvium aquifer as recharge. Flow manipulation has altered the original flow pattern of the alluvium aquifer which recharges both the bedrock (deep flow system) and the Schuylkill River. Four wells are used for monitoring. This recovery system has been effective in controlling off-site migration of pollutants.

The data presented on the graphs contained in Figures 3-5 through 3-8 illustrates the problems of the pollution to the ground water as well as the effectiveness of the use of the recovery wells. No graphs illustrating iron, phosphate, or manganese contamination are included. Early sampling for iron was affected by contamination by the iron casings in the wells. Phosphate and manganese results are too vague to indicate consistent contamination or trends.

Firestone has discontinued their tire manufacturing plant so less material is now being landfilled. Their chemical plant will continue use of the seepage lagoons and landfill. Therefore, the recovery system should be adequate to control the water flow system and the migration of pollutants. Monitoring will continue on a quarterly basis.

Firestone paid $40,000 for a hydrogeologic study to determine the best means of leachate control and for the placement of the recovery and monitoring wells. Another $210,000 was used for revisions to the permit application and revisions necessary to complete the landfill expansion.

CONCLUSION

Firestone has attempted, through several types of remedial action, to control leachate migration from their Pottstown facility. There has been a threat of contamination to the ground water (a two aquifer system) and to the surface water (Schuylkill River).

Firestone converted their open dump to a landfill in the early 1960's. This helped control surface conditions (blowing litter, etc.). No data is available to determine whether this influenced the leachate entering the ground water, soil, or the Schuylkill River.

In 1974 and 1975, Firestone closed their earthen lagoons and built two new lined lagoons. They also initiated a ground water recovery system which manipulated the flow of ground water

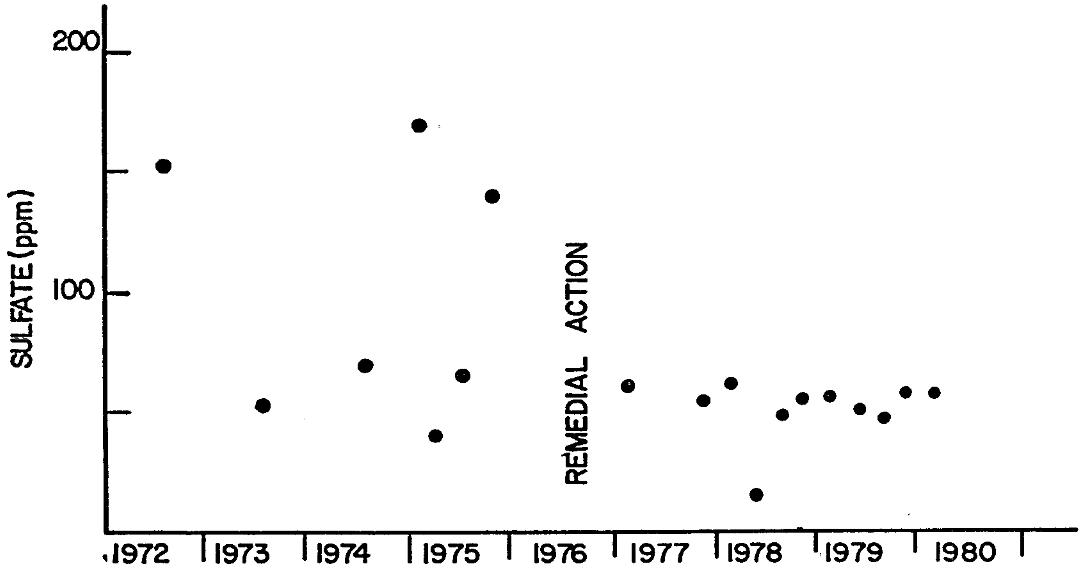


Figure 3-5. Sulfate concentrations in the ground water before and after the use of the recovery wells.

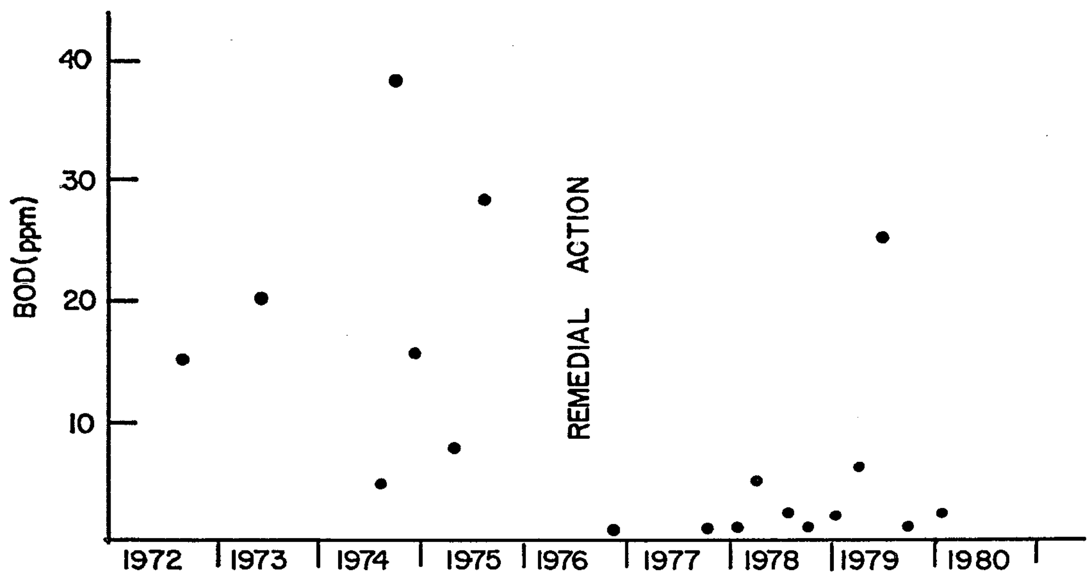


Figure 3-6. Five day BOD in the ground water before and after the use of recovery wells.

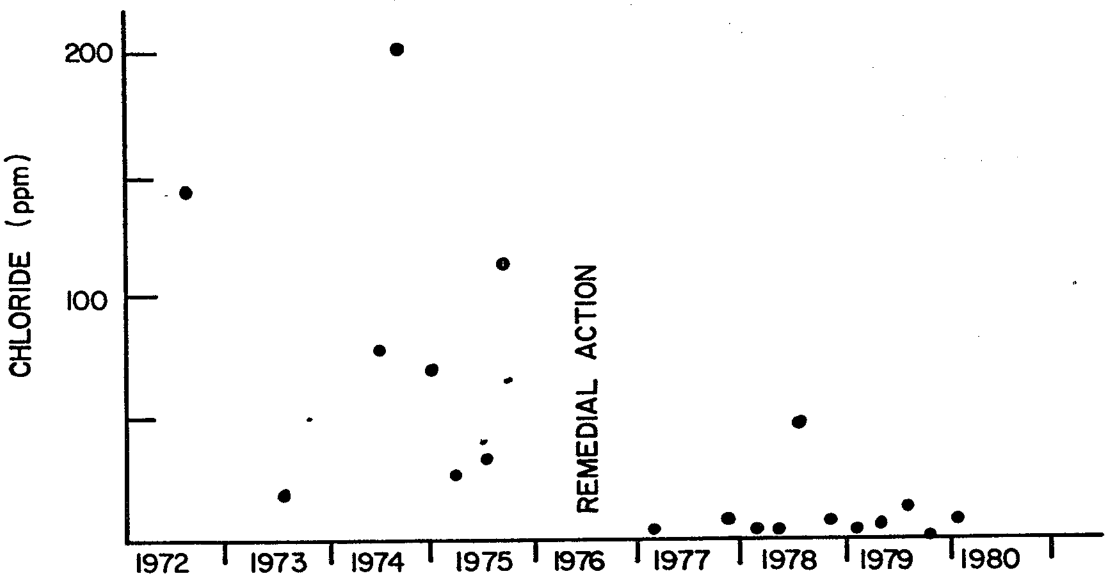


Figure 3-7. Chloride concentrations in the ground water before and after the use of recovery wells.

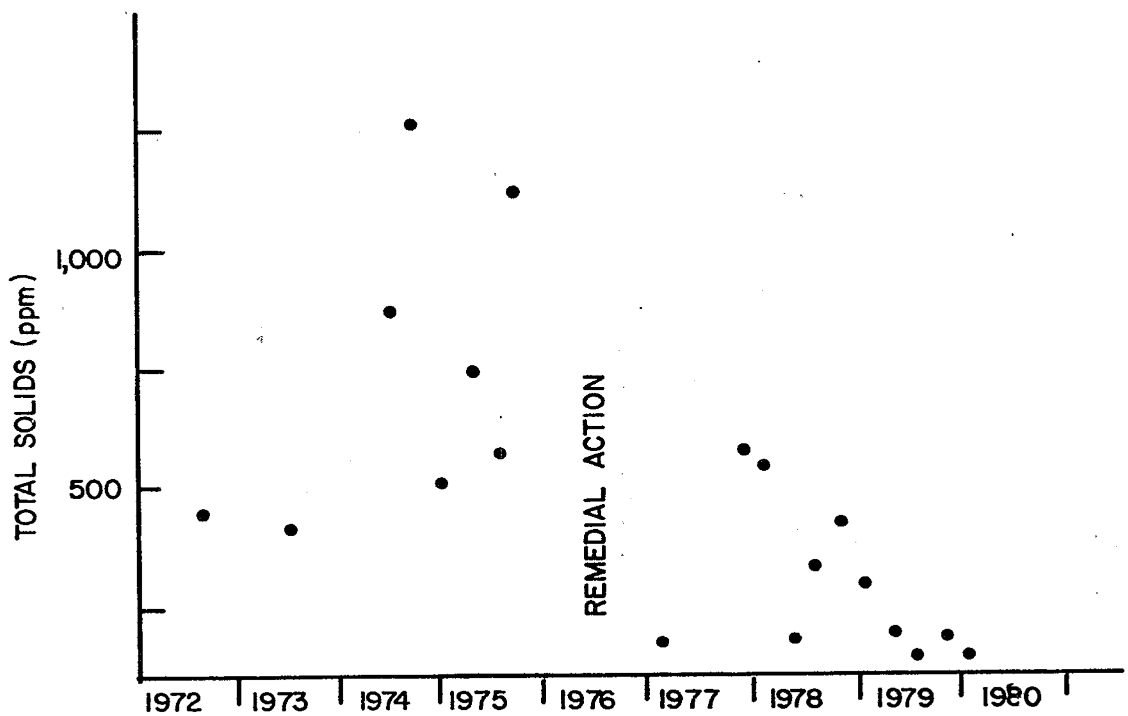


Figure 3-8. Concentration of total solids in the ground water before and after the use of the recovery wells.

to prevent off-site migration of pollutants. These two actions occurred close enough in time and location to make it necessary to assess their effectiveness simultaneously. Both the supporting data and persons with the Pennsylvania Department of Environmental Resources indicate that no off-site migration of pollutants is occurring now. It is predicted that the threat of contamination to the ground water and to the Schuylkill River will lessen with the closure of the tire manufacturing plant. The cost of the hydrogeologic study and the recovery wells ($250,000) as a preventive measure is much less than the cost of extensive cleanup of migrating pollutants which could have appeared in the ground water and in the Schuylkill River.

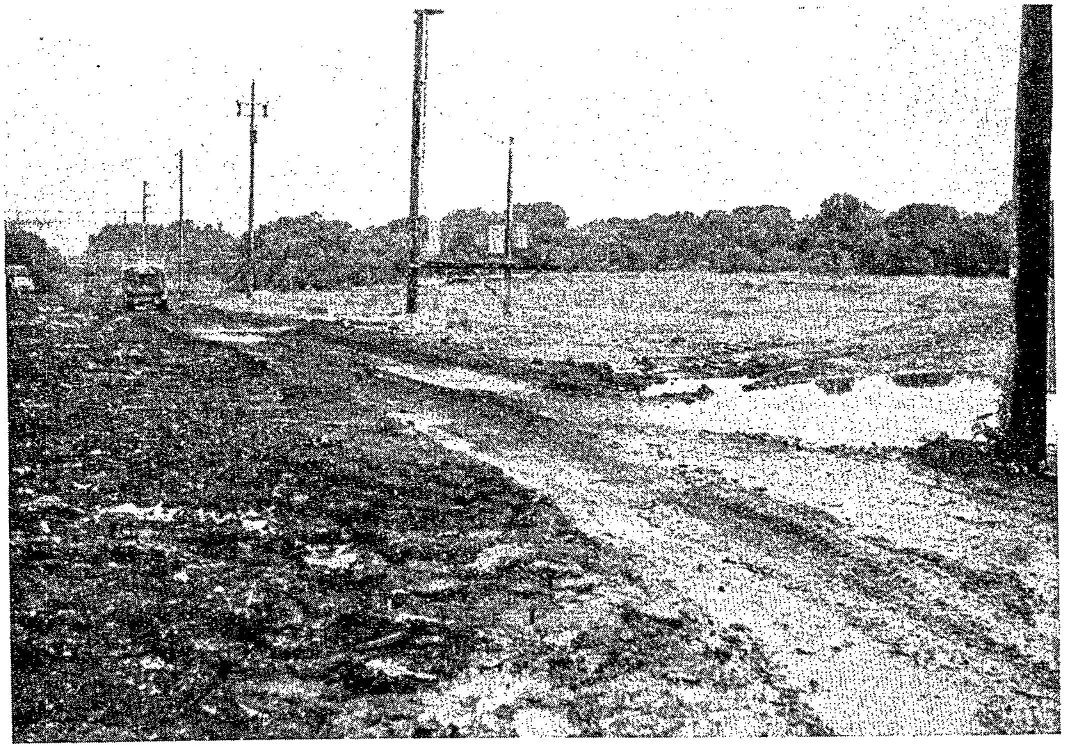
SITE B REFERENCES AND BIBLIOGRAPHY

3-1 Martin and Martin, Inc., and Todd Giddings and Associates. Report to Department of Environmental Resources on Hydrogeology of the Existing Landfill, Proposed Landfill, and Sludge Lagoons: The Firestone Tire and Rubber Company, Pottstown, Pennsylvania. 1975.

3-2 Pennsylvania Geological Survey, Pennsylvania Geological Survey Report W-22.

APPENDIX 3-1

SITE B PHOTOGRAPHS



View of part of the old landfill. Note access road and trees (which border the river) in the background. Ponded water is the result of a recent rainfall.

View of the edge of the old lagoon. The final cover and vegetation were quickly established.

View from the old lagoon looking toward the proposed area for the new lagoon.

View of the old lagoon's final cover and vegetation.
Numerous deer tracks were seen.

SECTION 4

SITE C

ANONYMOUS WASTE DISPOSAL COMPANY DUMP SITE EAST-CENTRAL NEW YORK

INTRODUCTION

Since 1958, the discharge of hazardous wastes from a dump site in east-central New York has been of concern to local residents and to the State and County Health Departments. Despite warnings from the State and County and complaints from local residents, the Company continued to accept wastes from local industries for disposal. In 1964, the Company tried to contain the pollution by building a dam across the site outlet, in the process forming a waste lagoon. However, the dam was ineffective and waste continued to escape from the dump site.

In 1966, the State ordered the Company to stop dumping. Dumping continued, however, fish kills occurred, and the State Attorney General initiated court action. In 1968, the Courts ordered the Company to refrain from further discharges of wastes into nearby streams, to cease dumping at the site immediately, and to remove the wastes already there. The Company complied with the cease-dumping order. However, area residents complained again in Spring 1970, when heavy rains sent wastewater over the dam. The site was finally cleaned up by the Company between 1970 and 1974. The area was capped with soil and a ditch constructed to divert surface water around the site.

Concern over the effectiveness of remedial action developed several years later. Noticeable chemical and oil contamination of area streams was traced to ground water seeps at the site. Further, water, sediment, and fish samples from a downstream lake revealed the presence of polychlorinated biphenyls (PCB's), and these too were traced to the dump site. Additional remedial action, including the construction of a slurry wall, is now being considered.

SITE DESCRIPTION

The waste disposal site is located in a rural area approximately 24 km (15 mi) southeast of a large city, 6 km (4 mi) northeast of a small community, and 5 km (3 mi) from a lake in east central New York. Area residents and vacationers use the Lake for fishing and other recreational activities. The land is partly wooded and partly pasture land used for grazing. Several residents live in the vicinity of the dump site (see Figures 4-1 and 4-2).

When the waste disposal Company terminated its dumping operations in 1968 as a result of legal action by the State of

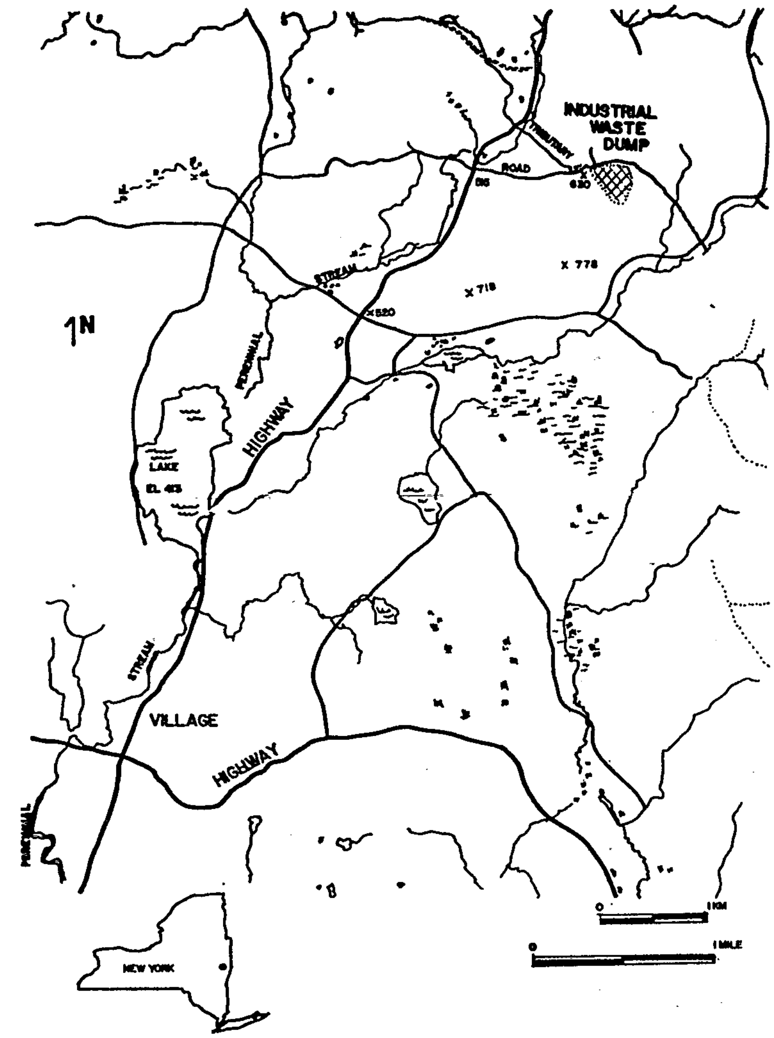


Figure 4-1. Site C location map.

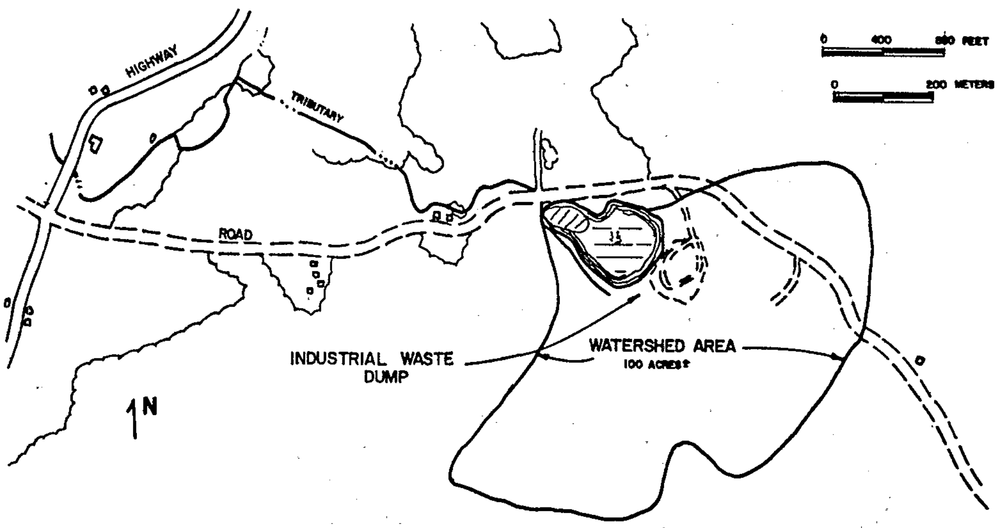


Figure 4-2. Site environs (1966 before closure).

New York, the operations included two wastewater lagoons, one oil pit, four above ground storage tanks, a storage shed, and a drum burial area on the south and eastern perimeter of the dump site. The lagoons, referred to as the lower and upper lagoons, were approximately 0.4 ha (1 ac) and 2 ha (5 ac) in size respectively, and were separated by an earthen dike. The dimensions of the earthen dam across the outlet of the lower lagoon were estimated at 14 m (45 ft) long and 3 m (10 ft) wide. The oil pit on the site was approximately 2 m (6 ft) deep and had an approximate area of 8 m (25 ft) by 46 m (150 ft). Four large steel oblong storage tanks, each having a capacity of 114 m^3 (30,000 gal), the storage shed, and the drum burial area are located on the eastern and souther sections of the site. The entire dump site was 4 to 6 ha (10 to 15 ac). Figure 4-3 shows the waste disposal dump site as it appeared in 1968.

The climate of New York State is representative of the humid continental type which prevails in the Northeastern U.S. The average annual temperature at the site is 14°C (58°F) and the average annual precipitation is 84 cm (33 in.). There are an average of 155 days between late September and early May with minimum temperature of 0°C (32°F) or less and 137 days with precipitation of 0.03 cm (0.01 in.) or more. The average annual snowfall is 168 cm (66 in.).

The dump site is the low point of a 40 ha (100 ac) watershed. Drainage from the dump site is through a small 0.8 km (0.5 mi) tributary stream to the upper reaches of a perennial stream. The perennial stream is approximately 3.2 km (2 mi) long and empties into the Lake north of the community, southwest of the dump site. Currently no surface water enters the site. Drainage ditches have been constructed around the dump site to divert all runoff. Originally, the waste disposal dump site was a flat, wet marshy area about 600 m (2,000 ft) long and averaging 75 m (250 ft) wide. The terrain sloped upward into a wooded area from the marsh.

Glacial deposits left during the Quaternary period mantle the entire region except for small isolated rock outcrops and recent alluvium. These glacial deposits differ considerably from one another in lithology and thickness, and may be divided into till, kames, and outwash. Till is a heterogeneous mixture of largely unsorted material ranging in size from clay to boulders, and topographically it forms the tops of the nearby hills. Owing to the lack of sorting and the presence of much fine material, the till has a low permeability and yields only small to moderate quantities of ground water. Overlying the till in most of the stream valleys are kames forming terraces and knobs of sand, gravel, and boulders. Meltwater along the edges of the glacier stripped the till and kame deposits providing the source for the accumulation of outwash (stratified stream deposits formed by glacial meltwater) in the deglaciated tributary and perennial

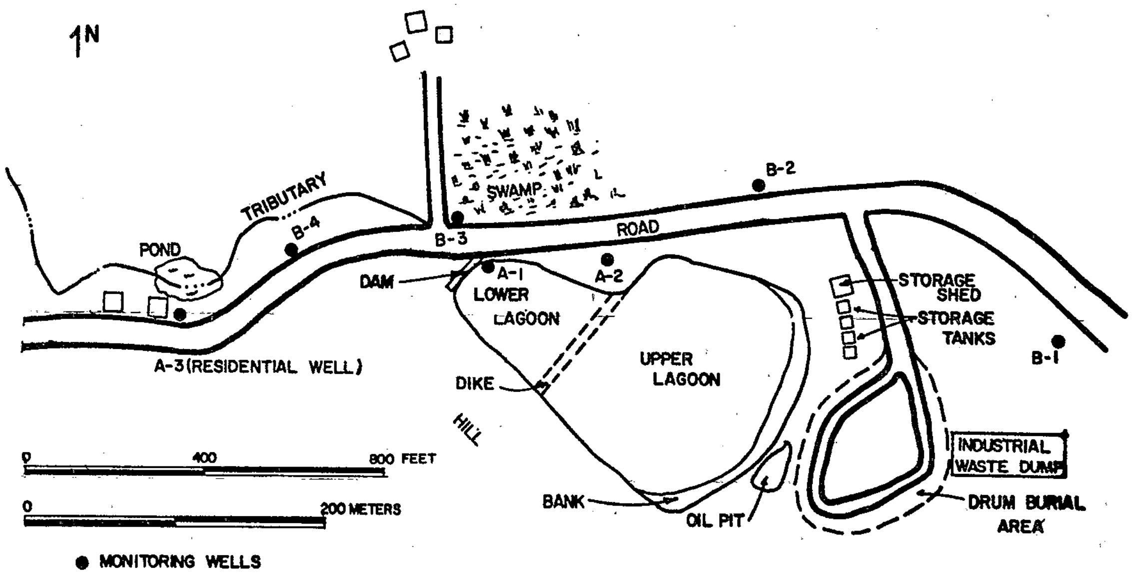


Figure 4-3. Facility layout in 1968 before closure.

stream valleys to the south. Ground water yields in the outwash average about 0.5 m^3/min (140 gpm). Thickness of the outwash material below the dump site is approximately 9 m (30 ft). Clays and silt alluvium cover the outwash. The thickest alluvium lies in the perennial stream near the Lake. A geologic cross section through the dump site showing bedrock, glacial deposits, alluvium, and the water level at the site is presented in Figure 4-4.

SITE OPERATION AND HISTORY

The Company operated as a private scavenger service collecting and disposing of waste chemicals and oils of various chemical and industrial plants in east-central New York. Hazardous waste materials were collected in 0.2 m^3 (55 gal) drums and transported to the dump site. The contents of reuseable drums were dumped into the pit or into the upper lagoon. Unuseable drums were dumped either on the perimeter of the upper lagoon or in the drum burial area. Drums were later covered with soil using a medium size bulldozer. The pit was used to store and separate recyclable oily wastes. The non-recyclable contents were pumped into the lagoon or onto the ground surface.

The Company currently has a scavenger waste permit and is allowed to store oil in the four oil tanks. The oil tanks operate as a backup storage and transfer station for oily wastes which are disposed of at a New Jersey site. There are no longer any lagoons or pits to dispose wastes, including water from oil tank trucks. However, hundreds of drums remain at the site, many of them unburied. Some waste still remains in the drums and has dried to a tar-like consistency; most of the drums have leaked onto the ground.

During the period of active dumping from 1955 to 1968, large amounts of oils and chemicals were dumped at the site. Industrial wastes dumped in the area included toluene, silicone, benzene, xylene, phenols, polychlorinated biphenyls (PCB's), isopropanol, acetone, methanol, butanol, trichloroethylene, methylchloride, oils, and paints. Portions of the waste oil were from cutting and cooling operations and contained impurities, such as metal grindings, filings, and silicone.

During 1965, one industry disposed of 3,340 m^3 (883,000 gal) of silicone-contaminated wastes through contract with the Company. The industry estimates the total quantity of waste material taken by the Company in the 1960's at approximately 13,617 metric tons (15,000 tons), much of it liquid solvents or water solvent mixtures. A substantial quantity of filter cake and other solids, often saturated with solvents, was also removed.

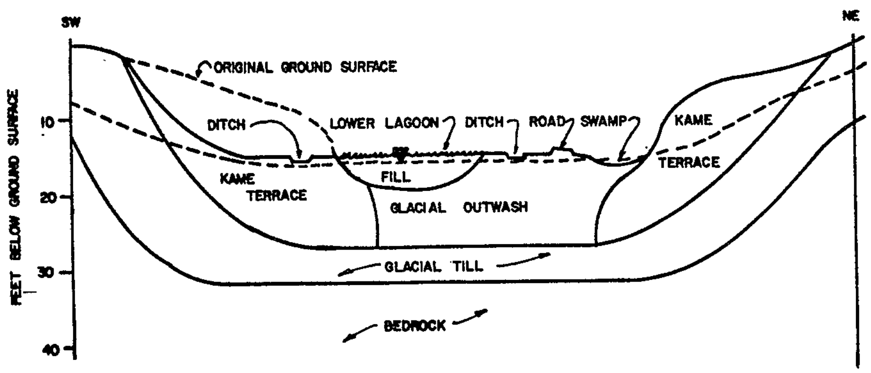


Figure 4-4. Generalized geologic cross section of Site C in 1980.

Another industry disposed of 3,460 m^3 (914,000 gal) and 17 metric tons (19 tons) of wastes from April 1, 1965 to April 1, 1966. For seven years, from 38 to 57 m^3 (10,000 to 15,000 gal) of wastes were received from a third company.

In August 1953 the owner of the Company acquired the property for industrial waste disposal activities. The property was in an undeveloped area of east-central New York and at the time seemed to be an ideal location for waste disposal operations. At the smae time, area residents were informed what the property was to be used for, but there were no objections to the purchase.

During the summer of 1955, the Company initiated their scavenger service for the collection and disposal of wastes, chemicals, and oils from various industrial establishments. In late October 1958 the County Health Department received a complaint from a property owner adjacent to the dump site. The owner reported that the Company's dumping had contaminated his pond and well. As a result, the property owner was forced to obtain water from another source for domestic use. A County Health Department inspection was the first indication that a serious water pollution problem existed.

A year later, in October 1959, the County Health Department received additional complaints that waste oil products were seeping from the property and damaging livestock and private wate supplies. The Company was advised of the continued complaints and was again instructed to confine their waste discharges. Steps were undertaken by the Company to regrade the property so that drainage of oil from the dump site was minimized. The Company stated that in the future, oil received would be promptly burned and not permitted to accumulate. However, the complaints persisted, and follow-up inspections by the Health Department were conducted. Each inspection reached the same conclusion:

1. Conditions at the dump site were not improving.

2. Freshly dumped oil and chemical wastes were found at the dump at each visit.

3. Oil and chemicals were observed in the tributary and on farm ponds.

4. Strong chemical odors pervaded the area and some discharges were found in the Lake

In March 1963, inspections indicated evidence of repeated oil and chemical discharges. At various points along the tributary and perennial stream to the Lake, evidence of No. 2 fuel oil and silicone odors was evident.

Warned by the State and County Health Departments about further discharges, the Company constructed dikes and diversion ditches around the disposal area to contain the waste chemicals and oils. However, the dike and diversion ditches were only temporarily effective. In September 1963, residents prepared a petition requesting that further dumping and burning of wastes at the dump site be discontinued. In May 1964, the Company constructed an earthen dam across the outlet of the swamp to pond the wastes in a lagoon. This measure was largely ineffective in controlling discharges; sludge still leaked from the dam and entered the stream as before.

On July 31, 1964 the County Health Department recommended that surface disposal of waste be eliminated, and scum, sludges, and other deposits collected and enclosed in impervious containers as soon as possible. In order to discharge, the Company would need a permit to comply with the law. Because voluntary pollution abatement was not successful, and because open dumping and burning of wastes continued, causing a serious public health hazard, legal action against the Company was initiated in September 1964. The Company continued to act in violation of water standards adopted by the State and to discharge wastes without a permit.

In April 1965, drums of contaminated gasoline, spilled by a bulldozer, caught fire and spread to the lagoon. Complaints of burning at the dump were received. Dense smoke and odors were prevalent in the area. Fire spread to the wooded area surrounding the dump. Several months later in July 1965, another serious fire broke out when chemicals stored at the site ignited spontaneously while attempts were made to cover the drums.

In 1965, amendments to the Public Health Law allowed the State Health Department to take more effective measures against polluters of the State's waters. An administrative hearing was convened by the State Commissioner of Health during September 1966, at which time an order was issued directing the Company to stop dumping its wastes by the end of October 1966, and to remove the remaining wastes from the site by April 1, 1967.

Despite the Commissioner's order, dumping operations were not halted. Numerous field inspections by the Health Department revealed that chemical wastes were being dumped into the lagoon and the lagoon outlet was leaching to the tributary. Deposits of a yellow-orange colored substance covered the tributary's bottom soil and rocks, and oil slicks were observed in one location. Inspections in 1967 revealed hundreds of drums were still being dumped at the site. In October 1967, a 15 cm (6 in.) diameter valve outlet pipe to the tributary was inserted in the edge of the lagoon providing a direct outlet for the waste. The outlet and additional construction, including a dike dividing the lagoon into upper and lower lagoons, violated the Public Health Law which required permits for such activities. These actions were responsible for fish kills and pollution of the perennial stream.

To enforce the Commissioner's order and to prevent the Company from further endangering the public health, the case was formally referred to the New York State Attorney General's Office on May 31, 1967. Court action was initiated on August 8, 1967, ordering the Company to cease disposal of wastes at the site. Dumping was finally terminated in 1968.

POLLUTION

During the period of active dumping between 1955 and 1968, large amounts of oils and chemicals were dumped into the lagoons and oil pit. Hundreds of drums containing chemical wastes were also scattered along the perimeter of the property, in the lagoon, and buried in the dump site. Many drums ruptured or were opened, their contents spilling onto the ground surface and/or into the lagoons. Waste leached into subsurface soils from buried leaking drums. With each rainfall, waste washed or leached into the lagoons. The lagoons and oil pit were often heavily coated with oil and sludge floating on the surface. Strong chemical odors were emitted from the site. Spontaneous and intentional fires were common and heavy clouds of acrid smoke drifted over the adjoining countryside.

Some oils and chemicals leached from the drum burial site and lagoons into a swampy area north of the dump site. At the outlet of the lagoon, oils, chemicals, and sludge frequently leaked into the tributary through holes breeched in the dam by runoff.

Numerous documentations were made concerning chemical wastes and oils entering the tributary, perennial stream, and Lake. The tributary flowed through several farm pastures used as grazing land for cattle. Cattle illnesses and deaths were reported. A pond in the tributary accumulated a 7.6 cm (3 in.) layer of oil, often killing ducks, herons, and other wildlife or preventing them from remaining there. Several fish kills occurred in the perennial stream. In 1963 water in the perennial stream 515 m (1,700 ft) downstream from its confluence with the tributary was contaminated with trichloroethylene and toluene and was fatal to test fish within 12 minutes. In 1966 the water in the tributary about 1.8 m (6 ft) above its confluence with the perennial stream diluted with an equal volume of water was fatal to test brown trout within four hours. The fish kill and absence of aquatic fauna was a result of high phenol concentrations. Water samples taken in 1965 and 1966 above and below the confluence of the tributary and perennial stream and in the tributary showed conclusively that the source of phenols was the dump site. The perennial stream above the tributary contained phenols at 5 ppb. The tributary varied in phenols content from 29 ppm to 99 ppm. The perennial stream below the tributary varied in phenol content from 86 ppb to 774 ppb.

Residential wells were contaminated during the time of the fish kills. In some cases it was felt that the contamination was not necessarily due to ground water influence, but due to surface waters intruding into the wells from the tributary which flows alongside the wells. However, it was believed that contaminated surface water had slowly percolated to the ground water table and that neighboring wells located in the direction of ground water flow had become contaminated. Table 4-1 presents data from water samples taken in March and April 1966 in the tributary, perennial stream, wells, and springs.

REMEDIAL ACTION

In the spring of 1970, a large quantity of waste products was discharged from the lagoon with surface runoff and swept downstream into the Lake, leaving a film coating on the surface. State and County health officials recognized the need for further action. In a final effort to purge the lagoon of its pollutants, health officials issued a burning permit to the operator. The object was to "burn off the top" of the lagoon, destroying as much as possible of the floating wastes. Whatever wastes remained were to be "skimmed off" by the operator and placed in sealed drums.

Because of the weather conditions and the serious air pollution problem and fire hazard that would be created from the burning, State and County officials re-examined the situation and suspended the burning permit. There were many dead trees surrounding the lagoons and it was believed that if the lagoons were set on fire the dead trees would probably catch fire also. In addition, any type of burning was ruled out because of the concern of the toxicity of the combustible products and the large number of unknown chemicals in the lagoons.

Other alternatives considered included skimming the wastes from the lagoons and burning them at another site or applying straw or wood chips on the lagoon to induce "accelerated bacterial decomposition". Another alternative considered was filling the lagoons, constructing a ditch to divert the stream, and regrading the site. A final alternative considered was pumping the lagoon contents into open sand beds to filter out the wastes, filling the lagoon, and removing remaining wastes to a sanitary landfill or other burial site.

Discussions between State and County representatives in a June 1970 meeting resulted in an agreement that the Company should undertake immediate steps that would serve to abate the problem. To guarantee the Company would take the necessary actions, a schedule for immediate and long term measures to cleanup the lagoon was developed, including the following tasks and deadlines:

TABLE 4-1. WASTE DISPOSAL COMPANY SAMPLING (1966)

Date	Sampling Location/Source	Phenols (ppb)	pH
3/25/66	Lagoon - 30 m (100 ft) from discharge	148,000	--
3/25/66	Discharge from lagoon	134,000	--
3/29/66	Lagoon - northwest end	140,000	5.0
3/29/66	Pond overflow	14,600	6.5
3/29/66	Tributary	8,600	7.2
3/29/66	Perennial stream - below tributary	86	7.3
3/29/66	Perennial stream - above tributary	<5	7.1
3/29/66	Dug well - Residence A	11.2	6.3
3/29/66	Spring supply - kitchen tap - Residence B	<5	6.8
4/5/66	Dug well - Residence C	293	6.3
4/5/66	Dug well - Residence D	6.2	6.9
4/5/66	Dug well #1 - Residence E	<5	6.5
4/5/66	Dug well #2 - Residence E	10.4	6.5

1 m = 3.3 ft

1. A competent water pollution abatement engineer was to be retained by the Company by July 15, 1970.

2. A report addressing the extent of pollution, the nature of the wastes, and proposals for pollution abatement was to be completed by October 30, 1970.

3. A satisfactory and stable dam was to be completed to contain the polluted waters in the two lagoons at the site, and the outlet pipe was to be removed by July 31, 1970.

4. A ditch was to be completed diverting the influent stream, and necessary grading was to be completed to assure that no further runoff would enter the lagoons by July 31, 1970.

5. All floating pollutants were to be removed from the lagoons and disposed of in an acceptable manner by August 31, 1970.

In complying with the schedule, the Company encountered problems, particularly because they elected to fill in the lagoons rather than building a satisfactory and stable dam. Described below for each of the tasks in the schedule is a description of some of the problems encountered and the effectiveness of each task in abating the pollution:

1. Retain a Competent Water Abatement Engineer by July 15, 1970. In early July 1970, initial contact was made with a local professional engineering and surveying firm acceptable to the State and County Health Departments. In early August 1970, the Company retained the engineering services of that firm.

2. Submit an Engineering Report by October 30, 1970. The report was submitted on schedule. Portions of the report have been incorporated in the following section.

3. Build a Satisfactory and Stable Dam and Remove the Outlet Pipe from the Dam by July 31, 1970. In July 1970, the outlet pipe in the dam was removed. Instead of building a dam, the Company chose to fill the lagoons with material from the adjacent hill in an apparent attempt to permanently solve the pollution problem. State and County officials gave informal approval to the proposed filling operations.

   In filling in the lagoons the initial plan was to section off the lagoons with dikes and then pump out the wastes into tanks. The filling operations began during July 1970. The initial earth-moving operation was directed towards creating a dike 0.6 to 1 m (2 to 3 ft) in height atop the dam for the purpose of preventing any further spills from the lagoons. A Company bulldozer created the dike and the Company then proceeded to fill in the lower lagoon which was about 0.4 ha (1 ac) in size. By mid-August 1970, the lower lagoon had been substantially filled.

In the ensuing months, filling operations in the upper lagoon were slow. The plan was to section off the upper lagoon area into two smaller lagoons with the construction of a new dike. The lagoon was to continue to be sectioned until filling operations were completed. The major reason for the slow progress was that it was much deeper than expected, in addition to having a much larger surface area. As a result most of the fill was saturated below the water level of the lagoon and was unstable, making it difficult for the bulldozer to pass over the fill. In the interests of securing firmer footing, the Company decided to await freezing weather before continuing the fill operations.

Subsequently, filling operations were conducted throughout the winter. As with the preceeding months, progress was very slow. By June 1971, only about five percent of the upper lagoon area remained to be covered. Further effort to fill and grade the former lagoon diminished by summer's end even though ponding of surface water was apparent, particularly in substantial depressions in the eastern part of the site farthest away from the lagoons. Limited filling and grading was done in 1972, 1973, and 1974. In 1973, the old oil pit was filled. The last filling and grading at the site was in October 1974. Additional fill material was brought in on the southeastern end of the upper lagoon. The number of depressions had been minimized and the regrading was essentially adequate. However, considerable ponding of water was noted in other areas near the old lagoons. No further effort has been made by the Company to complete the filling and grading operations since 1974 and the appearance of the site has remained relatively unchanged since that time. Some areas have been completely or partially overgrown by swamp vegetation and weeds. Otherwise, the fill material is exposed at the surface. The Company has made no effort to revegetate the site.

4. Construction of Diversion Ditch by July 31, 1970. Due to the Company's decision to completely fill the lagoons, the July 31 deadline could not be met. Construction of the diversion ditch was in conflict with the earth moving operations conducted at the site to cover the

existing lagoons, since the diversion ditch was continuously crossed by heavy equipment obtaining additional fill material. As a result, the Company requested and received a time extension from the State and County health departments.

Once the lower lagoon was filled, work proceeded with the construction of the diversion ditch on the west side of the lower lagoon. The plan developed by the State and County Health Departments and the consulting engineer was to maintain a minimum separation of 9 m (30 ft) to prevent seepage from the drum burial site and the former lagoon. The ditch was to be constructed in tight clay soil and a transit was to be used to assure that the diversion ditch had the necessary grade. Final sloping of the ditch was expected to be a relatively simple matter. When completed, the diversion ditch was to completely encircle the waste disposal site.

During the filling of the upper lagoon, attempts were made to build temporary diversion ditches. The diversion ditches were constructed with a sweep by a bulldozer blade. In addition, during filling operations, the ditches were frequently blocked with fill material. As a result they were not effective in diverting the surface water of the influent stream around the lagoons. Surface water from the influent stream running through the lagoons was a constant problem. However, the diversion ditches were effective in intercepting runoff from the hill where fill material was being taken to fill the lagoons.

Another major problem was that leachate was frequently found in the diversion ditches, mostly because the ditches were constructed too close to the lagoons. As a result, some chemicals seeped from the lagoons and drum burial site into the ditches. One case occurred in June 1971 where leachate from the former lower lagoon area had seeped into a ditch constructed adjacent to the former lower lagoon. The Company was immediately instructed to fill the ditch and construct a new ditch further away from the former lagoon. This action was completed the same day.

The diversion ditches were completed in 1973. They were excavated with a rented backhoe and graded to permit proper drainage. Since their completion, they have been effective in diverting considerable amounts of water around the former dump site area.

5. Removing All Floating Pollutants from the Lagoons and Disposal in an Acceptable Manner by August 31, 1970.

The Company removed the floating pollutants at the same time the lagoons were being filled. The liquids displaced by the filling operations had been pumped to a tank truck for salvage use. The largest portion of the surface skimmings consisted of waste oil, and this was used to spray dirt roads in the nearby towns in which the Company had contracts. Most of the floating pollutants that were in the lagoons were removed by December 1970.

Despite the skimming operation, pollutants at the site continued to be a major problem. This was predominantly due to surface water running into the lagoons, lagoons overflowing into the ditches and ground water seeping from the north bank of the upper lagoon. Leachate accumulated in the depressions of the filled portions of the lagoons where it had not been graded properly, forming small shallow ponds with floating chemicals and oils. Runoff or seepage of leachate into the diversion ditches was a constant problem. In addition, underground leaching from the lagoons and diversion ditches was also observed on the north side of the road in the swampy area opposite the dump site giving it a red-orange color and chemical-oily odor.

Completion of the diversion ditch in 1973 diverted considerable amounts of water around the dump site, thus reducing, but not preventing, leaching from the site. Ultimately, however, the leaching problem increased with time. Ground water continued to seep through the drum burial area and emerge from the north bank of the upper lagoon contaminated with chemicals and oils. To compound the problem, chemicals and oils began to surface from the drum burial site and lagoons, predominantly from chemicals and oils stored in leaking, deteriorating drums. Many buried steel drums have corroded and are now collapsing causing sinks in the cover of the site. In addition, it is believed that the severe winters in the late 1970's have had some effect in loosening the fill and allowing waste to percolate up through the soil. Heavy black oil and chemical seeps have been observed from the north bank of the old lagoon area. Ponding of pollutants and strong odors are becoming more prevalent and the marsh and tributary are becoming discolored.

Surface and ground water monitoring of the site has essentially been in two phases. In the first phase, two monitoring wells were installed approximately 90 m (300 ft) apart on the Company side of the road with one well located about 15 m (50 ft) from the watercourse culvert under the road (see Figure 4-2). Each well was placed about 1.8 m (6 ft) deep with 0.2 m (0.6 ft) diameter perforated bituminous fiber pipe as casing. In addition, an existing shallow well about 0.4 km (0.2 mi) downstream from the Company's property was used as a third monitoring well. This well served as a domestic water supply and had been contaminated earlier by discharges from the dump site.

Installation of the two monitoring wells on the Company's property took place in February 1973. Although analytical results showed contamination, they were not considered satisfactory. Wells were not properly sealed and the water in them was believed to be contaminated with surface runoff or overflow of high waters in the stream. Thus, the results were considered inconclusive.

Surface water monitoring at the site was very limited during cleanup. Grab sample analysis of lagoon wastewater, the marsh opposite the dump site, and the tributary by the consulting engineer using infra-red analysis techniques indicated the presence of hydrocarbon groups, such as petroleum residues, sulfur oxide, organic compounds, and substituted aromatic organic compounds.

The second phase of surface and ground water monitoring began in 1977 after indications of a redeveloping pollution problem. Ground water contaminated with oils and chemicals continued to seep from the north bank of the former lagoon and collect in pools where the fill had not been properly graded. Seepage into the marsh opposite the road and probable contamination of the tributary led to renewed monitoring of the dump site. The dump site was ordered by State and County officials to be placed on a regular monitoring and inspection schedule to determine the degree of contamination of the tributary and perennial stream.

Results of samples taken in 1977 and 1978 show low levels of contamination to the surface water although the tributary contained an orange color during warm periods of the year. Several ground water samples likewise showed low levels of contamination. Chemicals found in the water samples included those disposed of at the dump site, including xylene and benzene. In addition, polychlorobiphenol (PCB), a chemical used as an electrical insulator and a suspected cancer agent, was found in low concentrations escaping from the site.

Following additional sampling in the stream, it was decided that sediment samples from the Lake should be collected since PCB's were more apt to be detected in the sediments rather than in the water. Analysis of these samples showed PCB's (Aroclor 1260) in the Lake although not at extremely high levels. It was also decided that fish samples would be analyzed.

In the spring of 1979 fish samples were collected in the Lake. These samples showed levels of 19.23 mg/kg of PCB's in Large Mouth Bass and 63 mg/kg in samples of American Eel. Samples from a lake 10 km (6 mi) downstream showed the Large Mouth Bass to be less than 5 mg/kg. American Eel samples showed PCB levels of 6 mg/kg. In comparison, the PCB level guideline set by the U.S. Food and Drug Administration (FDA) is 5 mg/kg. As a result of the PCB levels found in the samples, the State Health Department warned residents against consuming fish in the Lake during November 1979 (a written advisory was not issued until May 1980).

Although the high levels of PCB's in the Lake were a good indication that the dump site was the probable source, the origin could not conclusively be determined without further investigation. Plans developed in November 1979 were to take additional surface and ground water samples from the tributary and perennial stream because officials thought the PCB's could be related to old leakage rather than new leakage. In addition, other sources of pollution could be involved including waste oil spreading activities on roads. Plans also called for the gathering of contaminated fish samples, as well as additional samples of sediment and the invertebrates which dwell on the Lake bottom. It was felt that sampling should be done in the quiescent areas of the Lake to determine how widespread the PCB's were on the Lake bottom.

In November 1979, hundreds of samples were taken from the Lake, the perennial stream, the tributary pond, and the swamp next to the dump site. Water samples from the swamp showed extremely high levels of PCB's. However, fish from the perennial stream and Lake had lower concentrations than those taken in April 1979. Fish taken from the perennial stream, regardless of species, had a PCB concentration in excess of 5 mg/kg and most fish from the Lake had PCB concentrations between 2 mg/kg and 5 mg/kg. The reason may be due to periodic flushing of the swamp. During periods of low flow such as the Fall, PCB's accumulate in the swamp. Then in the Spring or at other times of high runoff, PCB's are flushed out of the swamp into the tributary and perennial stream down to the Lake. Results of the April and November samplings are given in Appendix 4-1.

After the discovery of PCB's in fish, ground water from 15 wells was tested, including wells near the Lake and in the higher elevations near the dump site. Benzene, toluene, and xylene were found in a 19.5 m (65 ft) deep drilled well located along the road 180 m (600 ft) west of the dump site. Tests indicated the presence of 15 to 20 ppb benzene, versus the ground water standard of 5 ppb. This was the first indication that the wastes at the dump site were entering the ground water. The other 14 wells did not show excessive benzene levels.

To allow additional ground water monitoring in the immediate vicinity of the site, four monitoring wells were proposed in December 1979. The wells were installed in February 1980.

Preliminary analysis indicates that Wells B-2, B-3, and B-4 down-gradient from the dump site show ground water contamination. Monitoring Well B-1 up-gradient from the dump site shows no ground water contamination indicating that the dump site is the probable source of the ground water contamination.

CONCLUSION

Although problems at first were minimal, conditions at the site are growing steadily worse. The primary reason is that ground water is seeping through the very permeable fill material and is being contaminated by waste leaking from corroded drums. In addition, the severe winters in the late 1970's have aggravated the situation. It is evident that the remedial action was not effective and should not have been permitted. A more positive approach would have been to remove all pollutants, including buried drums and contaminated soil and water from the dump site to an approved landfill.

From laboratory analyses and the background history of the dump site, the following can be concluded about the recent problem of pollution in the Lake and streams: (1) the PCB problem in the Lake has developed over a period of several years and the most recent data indicates that a relatively small periodic discharge of waste is occurring from the dump site; and (2) PCB analyses of the various samples indicate the PCB's in the Lake originated from the dump site.

Based on the evidence of ground and surface water pollution and also the deteriorating site conditions, State and County officials have concluded further investigation will be necessary to conclusively determine what course of remedial action will be necessary to abate the pollution problem. To further identify the hydrogeologic condition of the site, field checks including geophysical studies and a more extensive drilling program have been suggested to substantiate existing data. This data will give additional insight into what types of remedial action should be undertaken. Remedial actions considered for the future have included the following:

1. Capping the lagoon with an impervious layer of fill and improving the grading of the existing fill to prevent seepage.

2. Installing impervious cutoff walls around the dump site through 6 to 9 m (20 to 30 ft) of gravel to a layer of glacial till below to prevent runoff and leachate from reaching the watershed.

3. Lowering the flow of ground water into the tributary by installing a subdrain or French drain.

Concern over the cost of investigative studies and remedial actions is a problem. Possible recovery of these cost through enforcement action and assessment of appropriate civil penalties are among the suggestions. The original court order issued to the Company to close the site can probably be used to order the necessary corrective action. In addition, the industries disposing of their wastes at this site may be requested to pay for a proportionate share of the site cleanup or face possible legal action. If these fail, a special remedial action fund available at the Governor's direction could be used to finance the cleanup.

SITE C REFERENCES AND BIBLIOGRAPHY

4-1 Personal communication and file review with David Knowles, Department of Conservation, Albany, New York. June 1980.

APPENDIX 4-1

WASTE DISPOSAL COMPANY SAMPLING (1975-1979) FOR SITE C

WASTE DISPOSAL COMPANY SAMPLING

DATE	TYPE OF SAMPLE	PARAMETER	RESULTS
South Side Drainage from Dump Site (Reaching Lake)			
11/20/79	Aquatic Organisms	Hydrophilid bettle (22)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	2.43 mcg/g
		Fingernail clam (Approximately 100)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	0.20 mcg/g
		Caddisfly larvae (35)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	0.78 mcg/g
Waste Disposal Company Dump Site			
3/8/79	Water (Leachate) Center of Fill Area	Benzene	>1,000 mcg/l
		Toluene	>750 mcg/l
		Xylene	>750 mcg/l
Dump Site - Outlet from Site			
9/26/75	Water	PCB 1016	< 0.25 mcg/l
		PCB 1254	< 0.25 mcg/l
6/9/77	Water (Leachate)	Phenols	0.046 mg/l
6/10/77	Water (Leachate)	Toluene	< 10 mcg/l
		Xylene	ND
		Benzene	< 10 mcg/l
		1,1,1-Trichloroethane	< 5 mcg/l
		Trichloroethylene	< 5 mcg/l
		Tetrachloroethylene	< 2.5 mcg/l
		Chloroform	< 5 mcg/l
		Carbon tetrachloride	< 5 mcg/l
		Bromodichloromethane	< 5 mcg/l
		PCB 1254	1.5 mcg/l
		PCB 1221	< 0.02 mcg/l
4/17/78	Water	1,1,1-Trichloroethane	<5 mcg/l
		Carbon tetrachloride	<5 mcg/l
		Bromodichloromethane	<5 mcg/l
		Chloroform	<5 mcg/l
		Trichloroethylene	<5 mcg/l
		Tetrachloroethylene	<2.5 mcg/l
		COD	74 mg/l
		Arsenic	<0.02 mg/l
		Silver	<0.02 mg/l
		Cadmium	<0.02 mg/l
		Chromium	<0.1 mg/l
		Copper	0.05 mg/l
		Lead	<0.1 mg/l
		Mercury	<0.0004 mg/l
		Zinc	<0.05 mg/l
6/29/79	Water	PCB 1016	<0.25 mcg/l
		PCB 1254	<0.25 mcg/l
Swamp - North Side of Road at Dump Site			
11/20/79	Aquatic Organisms	Dytiscide bettle (15)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	186.64 mcg/g
		Giant water bug (5)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	10.76 mcg/g
		Caddisfly larvae (Approximately 25)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	65.64 mcg/g

WASTE DISPOSAL COMPANY SAMPLING (continued)

DATE	TYPE OF SAMPLE	PARAMETER	RESULTS
60 m (200 ft) West of Dump Site			
11/7/79	Water	Benzene	< 1 mcg/l
		Toluene	< 1 mcg/l
		Xylene	< 1 mcg/l
		Gasoline, kerosene, lubricating oil, fuel oil	ND
Perennial Stream and Tributary Junction			
11/7/79	Fish	Wite Sucker (3)	
		PCB 1260	10.89 mcg/g
		Blacknose dace (4)	
		PCB 1260	23.55 mcg/g
		Tesselated darter (1)	
		PCB 1260	30.26 mcg/g
		Longnose dace (2)	
		PCB 1260	28.97 mcg/g
		Creek chub (8)	
		PCB 1260	5.22 mcg/g
		Creek chub (1)	
		PCB 1260	14.1 mcg/g
		Creek chub (4)	
		PCB 1260	5.35 mcg/g
		Fallfish (2)	
		PCB 1260	9.43 mcg/g
		Fallfish (2)	
		PCB 1260	8.92 mcg/g
		White sucker (6)	
		PCB 1260	19.10 mcg/g
		White sucker (4)	
		PCB 1260	15.34 mcg/g
		White sucker (2)	
		PCB 1260	16.67 mcg/g
		White sucker (2)	
		PCB 1260	16.71 mcg/g
11/20/79		Crayfish (O.limosus 2)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	2.54 mcg/g
		Dragonfly nymph (6)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	1.98 mcg/g
		Caddisfly larvae (36)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	0.93 mcg/g
Pond			
11/21/79	Aquatic Organisms	Isopods (Apx.100)	
		PCB 1016	0.63 mcg/g
		PCB 1254	1.23 mcg/g
		PCB 1260	ND
11/21/79	Aquatic organisms	Cranefly larvae (23)	
		PCB 1016	0.34 mcg/g
		PCB 1254	0.84 mcg/g
		PCB 1260	ND

WASTE DISPOSAL COMPANY SAMPLING (continued)

DATE	TYPE OF SAMPLE	PARAMETER	RESULTS
Perennial Stream - Between Lake and Tributary			
11/7/79	Fish	Brown Trout (2)	
		PCB 1260	10.85 mcg/g
		PCB 1260	0.31 mcg/g
		White sucker (4)	
		PCB 1260	2.63 mcg/g
		White sucker (7)	
		PCB 1260	2.4 mcg/g
		White sucher (3)	
		PCB 1260	7.01 mcg/g
		White sucker (1)	
		PCB 1260	0.25 mcg/g
		Fallfish (1)	
		PCB 1260	3.87 mcg/g
		Fallfish (7)	
		PCB 1260	7.39 mcg/g
		Pumkinseed (1)	
		PCB 1260	0.66 mcg/g
11/20/79	Aquatic Organisms	Caddisfly larvae	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	ND
		Cranefly larvae	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	1.96 mcg/g
Perennial Stream			
11/19/79	Domestic Duck	PCB	Awaiting Results
11/20/79	Aquatic Organisms	Crayfish (O.limosus)(4)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	0.34 mcg/g
		Cranefly larvae (13)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	0.98 mcg/g
		Helgrammite larvae (8)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	1.93 mcg/g
Inlet to Lake			
11/20/79	Aquatic Organisms	Crayfish (O.limosus) (1)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	3.72 mcg/g
		Cranefly larvae (10)	
		PCB 1016	ND
		PCB 1254	ND
		PCB 1260	10.69 mcg/g
East Side of Lake			
11/14/79	Water	Benzene	<1 mcg/l
		Toluene	<1 mcg/l
		Xylene	<1 mcg/l
11/14/79	Water	Benzene	<1 mcg/l
		Toluene	<1 mcg/l
		Xylene	<1 mcg/l
11/16/79	Water	PCB	0.5 mcg/l
		Mirex	Resample 1/80 Neg.
West Side of Lake			
11/16/79	Water	PCB	0.4 mcg/l
		Mirex	Resample 1/80 Neg.

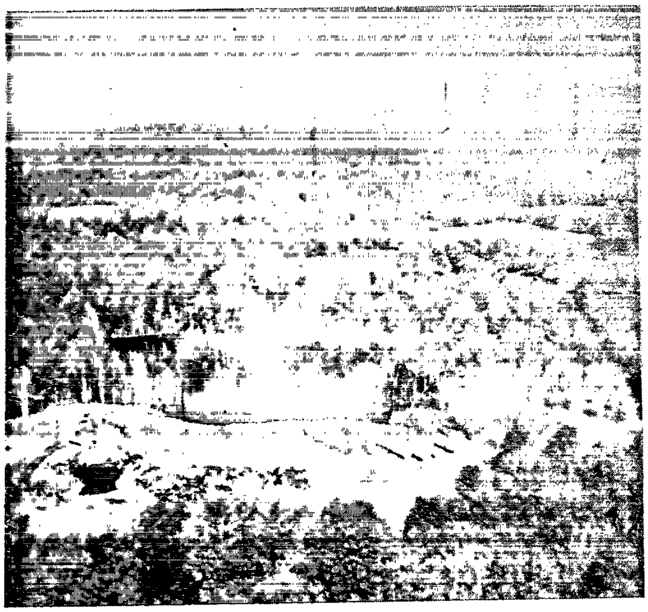
WASTE DISPOSAL COMPANY SAMPLING (continued)

DATE	TYPE OF SAMPLE	PARAMETER	RESULTS
Lake			
2/8/79	Sediment 61 m (200 ft) from Inlet	PCB 1221 PCB 1016 PCB 1254 PCB 1260 Mirex	< 0.01 mcg/g 0.02 mcg/g < 0.01 mcg/g 0.3 mcg/g < 0.01 mcg/g
	Sediment 122 m (400 ft) from Inlet)	PCB 1221 PCB 1016 PCB 1254 PCB 1260 Mirex	< 0.01 mcg/g 0.02 mcg/g < 0.01 mcg/g 0.5 mcg/g < 0.01 mcg/g
	Sediment 183 m (600 ft) from Inlet	PCB 1221 PCB 1016 PCB 1254 PCB 1260 Mirex	< 0.01 mcg/g 0.01 mcg/g < 0.01 mcg/g 0.4 mcg/g < 0.01 mcg/g
	Sediment 61 m (200 ft) behind Dame at Outlet	PCB 1221 PCB 1016 PCB 1254 PCB 1260 Mirex	< 0.001 mcg/g < 0.001 mcg/g < 0.001 mcg/g 0.01 mcg/g < 0.01 mcg/g
4/24/79	Fish	Largemouth bass(2) PCB DDT	 19.23 ppm 0.11 ppm
		American Eel (20 PCB - Average (Range) DDT - Average (Range)	 45.27 ppm 33.57 to 62.82 ppm 0.29 ppm 0.19 to 0.35 ppm

ND = not detectable

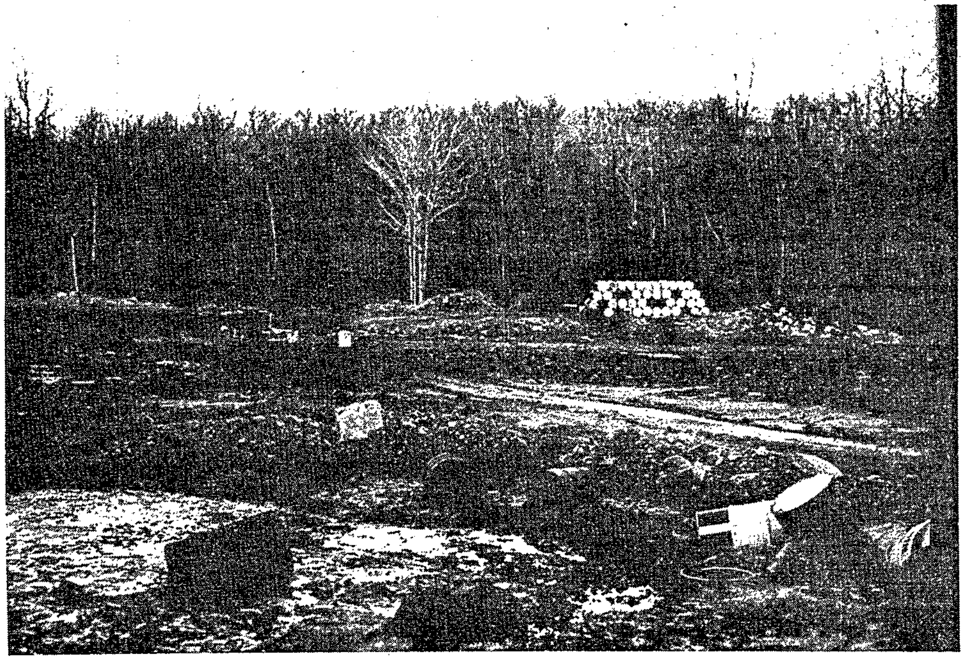
APPENDIX 4-2

SITE C PHOTOGRAPHS

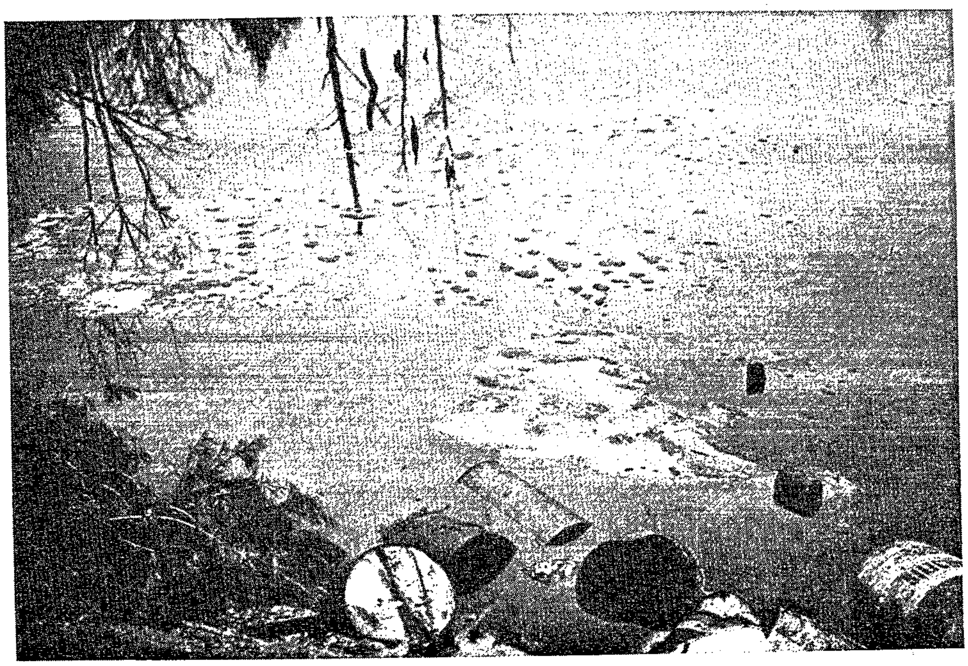


Aerial photograph of the dump site (1966).

The waste oil pit (1966).



Overview of the drum burial area (1966).



Bank of the lagoon (1966).

Overview of the site in June 1980.

Ground water seep from the bank of the former lagoon (1980).

SECTION 5

SITE D
DESTRUCTO/CAROLAWN
KERNERSVILLE, NORTH CAROLINA

INTRODUCTION

The Destructo Chemway Corporation and Carolawn Company, Inc. incinerator and drum storage site is located near the Town of Kernersville in North Carolina. In June 1977, while the facility was managed by Destructo, a chemical spill from the site contaminated Kernersville Lake/Reservoir which had served as the primary drinking water source for the Town of Kernersville.

Ninety to 99 percent of the fish in the 20.2 ha (50 ac) Reservoir were killed and over 200 people were forced to temporarily evacuate their homes. Fuel oil, toluene, allyl ether, xylene, dichloroethane, trichloroethane, and 2-methyl-1, 3-diallyloxy propane were later identified in the Reservoir's water. Since that time, Kernersville Lake has not been used as a drinking water supply, although analyses of water samples have indicated that toxic chemicals are no longer present in the Reservoir. The State of North Carolina has refused to approve the use of the water as long as a chemical disposal facility remains located within the Reservoir's watershed.

Carolawn began using the site after Destructo went bankrupt in 1978. Carolawn operated as a waste storage and transfer facility rather than a treatment/incinerator facility. In late 1979, the Town of Kernersville succeeded in forcing Carolawn to vacate the site. However, about 273 m^3 (72,000 gal) of chemicals were left behind when Carolawn vacated the facility.

Emergency cleanup measures initiated after the Destructo spill included (1) deploying a boom on a tributary to the reservoir, (2) placing sorbent material in the ditch from the Destructo/Carolawn site to the above tributary, (3) use of an underdrain spillway, (4) excavation of contaminated soil, (5) removal of dead fish, (6) placement of contaminated cleanup material in a lined pit on the property, and (7) installation of dikes around the tanks. This emergency cleanup activity was jointly funded by the U.S. Environmental Protection Agency (EPA), the Town of Kernersville, and the State of North Carolina.

Subsequent remedial activities associated with the Carolawn operation were funded by the property owner: Brenner Shredder, Inc./United Metal Recyclers. When Carolawn abandoned the leased property in early 1980, Brenner contracted Browning-Ferris, Inc.

(BFI) to remove the waste and regrade the site. Presently, the State believes the site has been improved to a reasonable degree, although some soil contamination remains on-site. State approval of future use of Kernersville Lake as a drinking water source will be based upon surface water and ground water monitoring to be performed in the future.

SITE DESCRIPTION

As shown in Figure 5-1, the Destructo/Carolawn site is located in north-central North Carolina to the west of the Town of Kernersville. The annual precipitation in the area is 118 cm (46.6 in.) and the annual snowfall is 148 cm (58 in.). The average wind speed is 12 kph (7.6 mph). The average daily high temperature is 15°C (55°F) with the highest daily maximum occurring in July at 31°C (88°F), and lowest in January at -1.7°C (29°F).

Little detail is known about the geology of the site due to a lack of sufficient boring logs. No rock outcrops appear within the general vicinity of the site. The site is located atop granite gneiss and schist bedrock of the Charolette Belt and the soils are estimated to be 3.0 to 4.6 m (10 to 15 ft) deep. The soil is a fine sand and loam with a high permeability of 5 to 15 cm/hr (2 to 6 in./hr). Starting from the ground surface the soil stratification is as follows: silt, clay, silt, and sandy silt.

The site lies on two terraces. The upper terrace is to the south of the property, next to Highway 66. The pit excavated by the U.S. EPA during the spill lies in the southeast corner of the propery in the upper terrace. This pit area would tend to drain toward the south, away from the Kernersville Lake. The lower terrace housed the old incinerator, two storage tanks, and 0.21 m^3 (55 gal) drums. The lower terrace to the north of the property and part of the upper terrace drains toward Kernserville Lake (see Figure 5-2).

The seasonal high water table is estimated to be between 1.8 to 10.4 m (6 to 34 ft) deep. Springs appear at a lower elevation northwest of the site, and these and other springs feed Kernserville Reservoir.

Kernersville Reservoir has a 435,275 m^3 (115,000,000 gal) capacity and was used as the primary drinking water source for the Town of Kernersville prior to the spill of 1977. Drainage from the Destructo/Carolawn facility enters an unnamed tributary about 2.5 km (1.5 mi) above the Reservoir and drains northward to the Reservoir. Kernersville Reservoir is man-made and has an earthen and concrete dam with a spillway at the southeastern end. Two surface streams and three undergound springs feed the

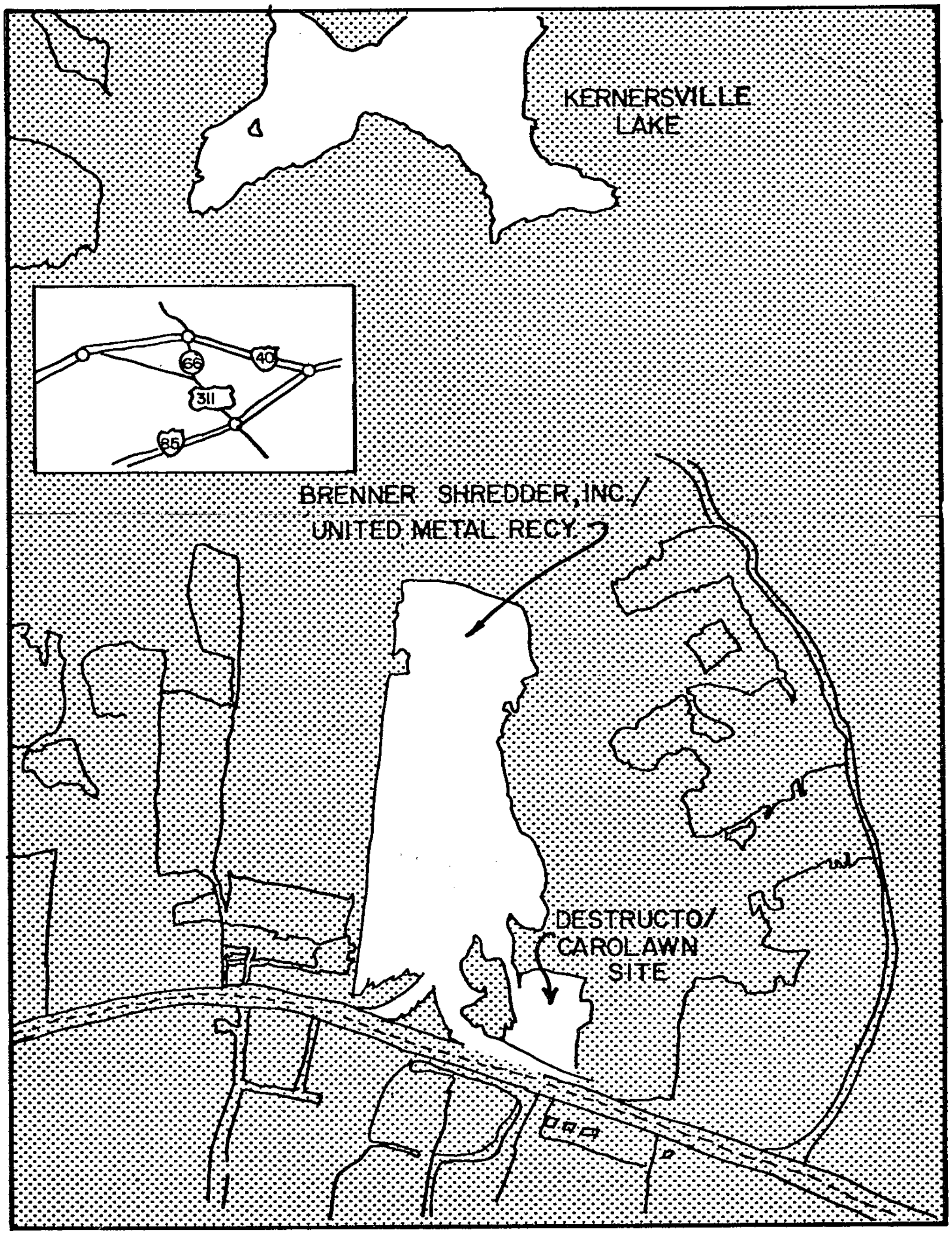


Figure 5-1. Site layout of Destructo/Carolawn site. [5-1]

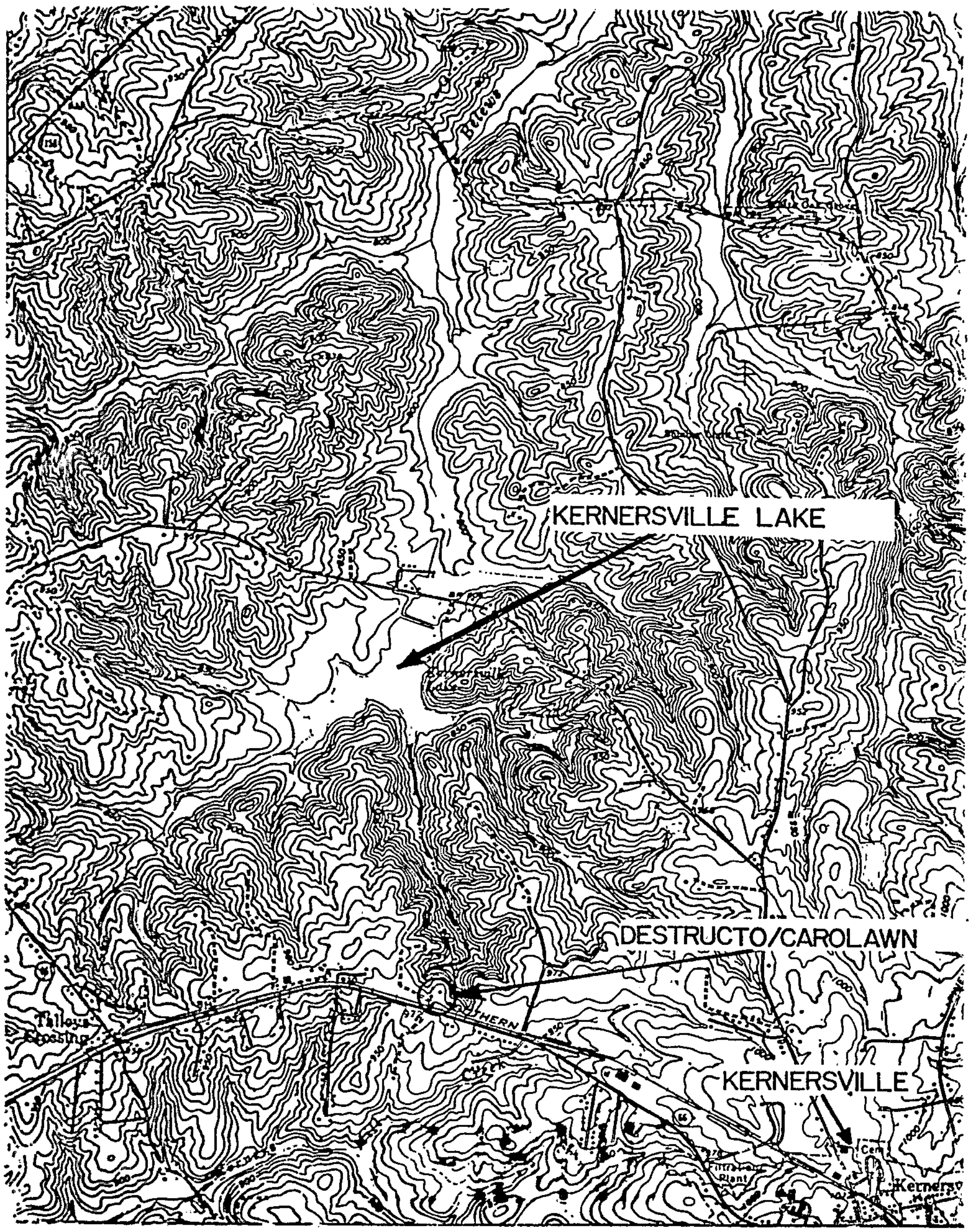


Figure 5-2. Drainage pattern of Destructo/Carolawn site. [5-2]

Reservoir. The Town of Kernersville requires about 0.06 m^3/sec (1.3 mgd) of water.

SITE OPERATION AND HISTORY

Destructo Chemway, Inc. began operating an industrial waste incinerator in 1974 under an air quality permit issued by Forsyth County. Approximately 1.6 ha (4 ac) belonging to Brenner Shredder, Inc./United Metal Recyclers was leased by Destructo to house their facility. Brenner operates a metal recycling operation on the property immediately adjacent and northeast of the Destructo site (see Figure 5-1).

During the site's active years, liquid wastes suitable for incineration were transported to the Destructo facility by truck from industrial customers. A tank truck of approximately 5.7 m^3 (1,500 gal) capacity was used to transport the liquid waste to the Destructo site. Once the waste had been transported to the site, the liquid waste was segregated according to its BTU value in five large storage tanks. The waste was then transported via PVC pipe to two tanks adjacent to the incinerator. The storage tanks had capacities of 11 and 64 m^3 (3,000 to 17,000 gal). Small quantities of commercial fuels were used to start up the incinerator. There were no dikes around the storage tanks, nor was there any form of secondary containment to contain spills. Likewise, the valves on the tanks could be opened by pulling a lever, since no locks had been installed.

According to the Destructo Plant Manager, the plant had originally been set up by Chemwaste Corporation (a division of Brenner) and had operated since 1974 without incident. When Destructo purchased the equipment from Chemwaste, it was agreed that the equipment would be moved to a more suitable location (outside the watershed), and that the new installation would be properly engineered with containment dikes around all tanks. [5-3] Neither of these conditions were met during Destructo operations.

After the spill of June 3, 1977, Destructo went bankrupt and Carolawn Company, Inc. took over the operation of the site in early 1978. Although company officials claimed that Carolawn was a different company, the State of North Carolina questioned the non-association, since Carolawn retained some of Destructo's officers. In early 1980, Carolawn vacated the site, leaving behind chemicals in corroded 0.2 m^3 (55 gal) metal drums. It is now believed that during Carolawn's active days, the facility was used more for storage and transfer than treatment, and that wastes were usually received in 0.2 m^3 (55 gal) drums, rather than in bulk tankers. Little is known concerning the actual operation of Carolawn since books (which were reportedly kept) could not be located. Thus, the type, quantity, and source of the wastes is not known. About 91 metric tons (100 tons) is reported to have been processed at this site through 1978. It is believed the Company operated with limited capital and that once the State prohibited further waste receipts, the Company had insufficient funds with which to perform cleanup activities.

When Brenner and the Town of Kernersville requested that Carolawn discontinue waste receipts and cleanup the site, Carolawn showed an initial interest in complying with the requests, but later abandoned the site. During this initial interest period, Carolawn was constructing a waste disposal plant in Fort Lawn, South Carolina about 72 km (45 mi) southwest of Charlotte, North Carolina. Approximately 80 drums had been transferred to South Carolina from the Kernersville site, when South Carolina prohibited further transfer of wastes to the Fort Lawn site. Carolawn had proposed to establish an incinerator in Fort Lawn to incinerate the wastes. However, when the State of South Carolina became aware of their poorly managed/supervised operations at Kernersville, it began regulating their Fort Lawn operations more closely. Carolawn subsequently abandoned the Fort Lawn site, leaving behind thousands of gallons of waste.

POLLUTION

Problems associated with the Destructo-Carolawn site generally have occurred in two phases. The first phase consisted of actual pollution of the Reservoir by the chemical spill of June 1977. The second phase consisted of a threat of surface water pollution due to the Carolawn waste storage and transfer operation.

On June 3, 1977, between 9 and 11 p.m., vandals entered the facility grounds and opened the valves on six storage tanks. The released chemicals flowed down a slope in a culvert, then through a dry ditch for about 0.4 km (0.25 mi), thence into an unnamed tributary, before entering the Kernersville Reservoir.

Table 5-1 provides general information on storage capacity and waste material housed in the tanks associated with the spill. Figure 5-3 displays Destructo's layout and the northwest flow direction of spilled liquid wastes. According to the officials of Destructo, Tanks 33 and 101 contained water contaminated with small amounts of alcohol, ketone, and toluene from Xylo Graphics Company. Tank 34 contained a mixture of allyl ether and water reportedly from Proctor Chemical Company. Tank 91 contained allyl ether (from which most of the water had been removed) reportedly from Gravely-Roberts Company, Tot Screen II, and Proctor Chemical.

A strong chemical odor (possibly ether) was present during the spill. Due to the unknown nature of the spill and the unusual odor, approximately 200 people were evacuated from the immediate area of the spill. During the excavation of the contaminated debris and soil and reservoir cleanup, 23 men were hospitalized with eye irritations.

TABLE 5-1. STORAGE OF WASTE MATERIALS AT DESTRUCTO CHEMWAY CORPORATION [5-4]

Tank No.	Available Capacity (m^3)	Quantity Discharged: Oily Water (m^3)	Oil (m^3)	Ether (m^3)	Total (m^3)
33	11	10.1	--	--	10.1
34	11	3.3	--	3.1	6.4
81	30	--	--	0.3	0.3
91	34	18.3	--	6.7	25.0
101	42	40.7	--	--	40.7
171	64	--	18.6	12.4	31.0
Total	192	72.4	18.6	22.5	113.5

m^3 = 264.2 gal

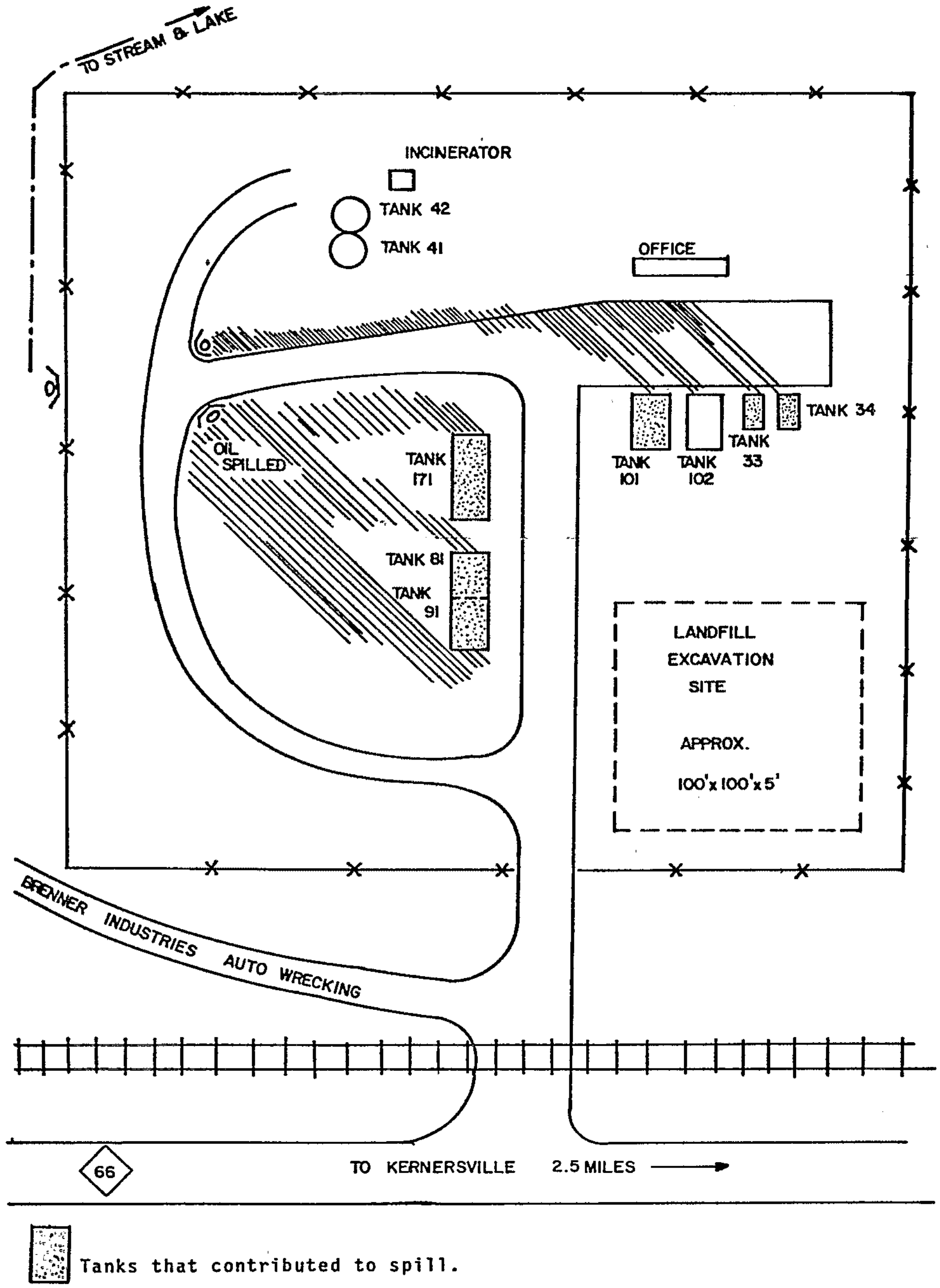


Figure 5-3. Tank location and flow direction of 1977 spill at Destructo Chemway. [5-5]

Two days after the spill on June 5, an extensive fish kill in the Reservoir began. The bottom-feeding catfish and carp were the first to be affected by the spill. By June 6, an extensive number of bottom-feeders died. On June 7, the fish kill continued with all but the bass dying, and by June 8, even the bass had died. The State Wildlife Resources Commission reported a 90 to 99 percent fish kill amounting to several tons. Prior to the spill, the Reservoir was reported to have had a balanced population of yellow perch, sun fish, pumpkinseed, bluegills, and bass. A total of 16 different species including shell crackers, warmouths, yellow perch, and bass died due to the contamination. The chemical later identified as likely causing the fish kill was 2-methyl-1, 3-diallyloxy propane; however, not enough data was taken to show the mechanism of the fish kill.

Samples of the reservoir water analyzed by U.S. EPA revealed the presence of fuel oil, toluene, allyl ether, xylene, dichloroethane, trichloroethane, and 2-methyl-1, 3-diallyloxy propane. Prior to the fish kill, the U.S. EPA believed that the chemical spill would not be soluble in water and that 20 percent of the chemical spill would be adsorbed into the ground as the spill ran along the ditch. Once the fish began dying and additional tests were conducted, it became evident that the material had become water soluble and that possibly some had later settled out to contaminate the floor of the Reservoir. As a result of the fish kill and analytical evidence, the Reservoir was declared by the State Health Department to be unsuitable for use as drinking water.

As a result, the Town shifted to alternate water supplies, obtaining approximately 40 percent of its water demand from the Winston-Salem/Forsyth system and 60 percent from an old supply lake. Water obtained from these two sources met only 67 percent of Kernersville's daily demand. Therefore, curtailment of water useage was necessary while connections were made to the adjacent town to provide the total water flow. Two textile mills in the area had to pay for delivery of water via tankers and for process modifications to conserve water. The water consumption at the two mills was cut by 90 percent and layoffs and cutbacks in working hours resulted from the water shortages. Adams-Millis Corporation, one of the textile mills, now receives its supply via private wells. Meanwhile, a temporary pumping station and a pipeline improvement project has increased the flow of water from the Winston-Salem/Forsyth system.

In 1978, Destructo vacated the site, with Carolawn taking over operations. Since that time, the North Carolina Division of Health Services has continued to test the water at the Reservoir and has found it to be within drinking water standards. Within 14 days of the spill, schools of newly hatched fish (golden shiners) were seen in the Reservoir and no second fish kill has been observed since. This evidence pointed toward the volatile nature of the toxic material. By October 1977, water samples showed that the concentration of all chemical compounds discharged from the Destructo facility were at less than detectable levels. In spite of this data indicating that resumed use of the Kernersville Reservoir as a drinking source was acceptable, the North Carolina Department of Health has refused to approve the use of the water as long as a chemical disposal plant remains located in the watershed near the Reservoir. Therefore, the problem associated with the operation of Carolawn at this site has involved the "threat" of pollution (not pollution itself) from the storage of waste chemicals within the Reservoir's watershed.

Brenner officials terminated Carolawn's lease in July 1979, requiring that they vacate the site within 30 days. Carolawn departed from the site between August and November of 1979, leaving behind their plant, equipment, and chemical wastes. The wastes left behind included lubricating oil, waste oil, waste paints, printing inks, and halogenated and non-halogenated solvents. Waste generators were reported to have included Monsanto, Dupont, Mobil Chemical, Piedmont Publishing Company, and Kingsport Press. The general characteristics of the abandoned wastes included the following categories: corrosive, toxic, ignitable, reactive, highly volatile, and flammable. Records reportedly had been kept by Carolawn, but were not available for review. The wastes left behind posed the following pollutant hazards:

1. Potential for runoff into the Town Reservoir.

2. Potential contamination of the food chain due to runoff.

3. Potential for fire.

Although earlier reports had indicated that only 45 m^3 (12,000 gal) of chemical wastes remained at the Kernersville Plant, it was later determined that 2,461 drums and 272.1 m^3 (71,880 gal) of chemicals in tanks (see Table 5-2) were left at the site. It is this waste which must be removed before the North Carolina Department of Health will approve use of the Reservoir for drinking water purposes.

REMEDIAL ACTION

As a result of the spill of 1977, the following corrective actions were instituted:

1. A floating boom containing sorbent materials was deployed at the mouth of the unnamed tributary into the Reservoir.

2. A large underflow siphon dam was installed at the stream junction to allow the lower zone of water to

TABLE 5-2. CAROLAWN'S INVENTORY AS OF JULY 31, 1978. [5-6]

Tank No.	Observed Volume	Actual Volume (m^3)
33	Full	12.7
34	Full	12.7
41	2.1 m high	8.4
42	Full	15.7
81	Full	29.0
91	Full	36.9
101	Full	41.3
102	Full	48.8
171	Full	66.6
Total		272.1

flow into the Reservoir. Later the siphon dam was modified with the addition of a blanket of peat moss to assist in the removal of dissolved organics. A catch basin and siphon dam were also installed at the road culvert as it exits the property.

3. Two straw barriers were constructed downstream from the source of the spill. However, only a small quantity of oil had accumulated behind the barriers indicating that most of the spilled material passed prior to the barrier construction.

4. Approximately 906 m^3 (32,000 ft^3) of contaminated soil was removed from the drainage swale leaving the site. Debris was also removed from the dry wash area. Soil was likewise excavated around the spilled tanks up to 2.4 m (8 ft) deep.

5. A landfill site 30 m x 30 m x 1.5 m (100 ft x 100 ft x 5 ft) was excavated on the upper terrace at the southeast corner of the facility site. The excavated pit was lined with 0.15 mm (6 mil) polyethylene plastic. Contaminated soil, debris, dead fish, and sorbent materials were placed in the pit with intermittent layers of agricultural lime. The filled pit was subsequently sealed with a 0.15 mm (6 mil) layer of plastic and with a layer of clay to prevent infiltration of precipitation.

6. The liquid from the two dams and from depressions along the creek bed were removed and stored in Tanks 81 and 91. About 150 m^3 (40,000 gal) of solvents stored in bulk tanks at the site were removed. Approximately one-third of the chemicals were removed from the site for incineration. Additionally, Industrial Marine Service from Norfolk, Virginia was contracted to remove oil and sorbent materials from the Reservoir. A dike and other safeguards were provided to prevent remaining chemicals from causing further contamination.

The principal action instituted during the spill consisted of attempts to contain the spilled material to prevent its migration to the Reservoir. Initial visual inspection of the Reservoir indicated that the measures might have been successful in containing the contaminant which at that time was reported to be allyl ether and 75 percent oil and water. Subsequent analysis and the fish kill identified other organic substances and 2-methyl-1, 3-diallylexy propane which had rapidly dispersed over the Lake. Since the spill, the fish population has been returning to the Reservoir and no second fish kill has been observed. Laboratory analyses likewise reveal that the contaminants have decreased to non-detectable levels.

During the spill, a mobile bioassay laboratory, analytical laboratory, and pilot treatment plant were used to determine if the Kernersville Wastewater Treatment Plant could be modified to use activated carbon in its treatment sequence. The concentrations of the toxicants were significantly reduced following carbon filtration. However, in fish mortality tests performed subsequently, some mortality did occur even though chemical analyses had failed to find the toxicants at detectable levels in the carbon-filtered water (see Table 5-3).

About $60,000 in U.S. EPA funds, $23,000 in Kernersville funds, $6,000 in State funds, and $25,000 in Fish and Wildlife Service funds were spent during the cleanup plus an undetermined number of man-hours required for cleanup activities. The water shortage after the spill magnified the problem.

Based upon the conditions at the site since the spill of 1977, further action became necessary before the people of Kernersville would be allowed to resume use of the Reservoir for drinking water. The State of North Carolina Health Department has insisted that the Town cannot safely begin using the Reservoir as long as a chemical waste disposal plant remains in the watershed. Therefore, Brenner, under pressure from the Townspeople, began eviction of Carolawn in April 1979. Carolawn's activities were reported to have ceased at the site about August 1979. In a proposal contract of January 1980, Carolawn was to remove all equipment, waste inventory and drums, and Brenner was to deposit $32,000 in the North Carolina United Bank to be paid to Carolawn upon completion of their corrective actions. After removing approximately 80-0.2 m^3 (55 gal) drums, Carolawn abandoned the site. Five times as much waste was found on the property in August 1979, as had been reported earlier. In August, it was estimated that approximately 272 m^3 (72,000 gal) of chemicals were stored in large tanks on the property along with about 2,500-0.2 m^3 (55 gal) barrels. Since Carolawn abandoned the site, the landowner pursued the cleanup activities by contracting BFI to remove the barrels, waste equipment, and the upper 15 to 30 cm (6 to 12 in.) of soil. BFI was also to apply imported soil to the site and grade and seed it. This corrective activity was completed during the Summer of 1980.

Barrels were segregated according to waste composition prior to removal. The landowner would not comment on the remedial activities of the site, but government officials reported that the major portion of removed waste (aqueous waste/ sludge) was sent to BFI deepwell injection and landfill facilities in Calcashieu and Livingston, Louisiana. Other waste (aqueous oil and chlorinated waste) was disposed in a BFI Baltimore, Maryland landfill and a small portion of removed waste was sent to an SCA facility in Pinewood, South Carolina. An estimate of the total remedial cost funded by Brenner ranges from $250,000 to $500,000.

TABLE 5-3. BIOASSAY STUDY [5-4]

Test	Fish and Water Type	Survivability Count*					
		0 hr	24 hr	48 hr	72 hr	96 hr	120 hr
1	Bluegill						
	Raw Lake Water	100	97	83	70	63	53
	Filtered Lake Water	100	100	97	87	87	63
	Control Water	100	97	97	97	97	97
	Catfish						
	Raw Lake Water	100	0	--	--	--	--
	Filtered Lake Water	100	100	100	100	80	60
	Control Water	100	100	100	100	100	100
2	Bluegill						
	Raw Lake Water (12 days after spill)	100	100	100	--	--	--
	Catfish						
	Raw Lake Water (12 days after spill)	100	91	91	--	--	--

* Percent of fish surviving at time intervals shown.

One of the procedures used in removing the waste consisted of withdrawing liquid waste from the 0.2 m^3 (55 gal) drums and transferring the liquid to a tank truck for transport to the BFI Louisiana facilities. Empty drums were crushed and removed along with contaminated soil from the site and likewise transported to an acceptable landfill. On June 23, 1980, as some of the remaining drums were being crushed for removal, a 17-year-old worker was sprayed as he was removing his protective face shield 18 m (20 yd) away. Although thought to be empty, the drum actually contained a 30 percent concentration of phenol. All efforts to revive the worker failed and the cause of death was later reported to be dermal toxicity in which all nerve impulses to the heart stopped.

According to government officials, cleanup activities are now reasonably complete. All free chemicals (i.e., drummed waste and sludge from a holding pond) have been removed. Both the upper and lower terraces have been graded and seeded with wheat straw and grass. Contaminated material remaining on-site consists of the top soil layer and the spill burial pit. Soil samples indicate soil contamination exists in some areas at depths up to 50 cm (20 in.). The pit containing contaminated spill debris was left intact. The State plans to install five monitoring wells (two around the spill burial pit with one up-gradient and one down-gradient) and three down-gradient from the entire Destructo/Carolawn site. Once surface water runoff and ground water has been adequately monitored, the State Solid and Hazardous Waste Division will submit a report to the State Water Supply Branch, which will make a determination on whether the Kernersville Reservoir can again be used for drinking water. If the ban on water use is removed, Kernersville will have the option to return to their previous water source.

CONCLUSION

Three years after 110 m^3 (30,000 gal) of chemicals spilled into Kernersville's drinking water supply, the Town's Reservoir remains unused. The State of North Carolina has banned use of the Reservoir as a source of drinking water as long as the existing chemical waste facility is located in the Reservoir's watershed. The equipment and waste were removed from the watershed by the land-owners, and depending upon results from ground and surface water sampling, the Town will soon have the option of resuming use of the Reservoir.

During the past three years, the residents have been sharply divided over whether use of the 20.2 ha (50 ac) Lake/Reservoir should resume (see Appendix 5-1). The decision to resume use of the Reservoir has become a heavily debated topic in the Town. A letter to the editor of the Kernersville News of January 1980 exhibits the sensitivity of this volatile issue.

This site provides an example of an entire Town's acute awareness of an environmental issue. The awareness was brought about initially by the need of a portion of the Town to evacuate their homes during the spill. Citizens within the vicinity of the Destructo site during the spill showed health-related effects including nausea, vomiting, headaches, and mucous membrane irritation. All of the Townspeople became aware of improper management of industrial wastes when the Town's water supply became contaminated. Loss of the Town's drinking water supply caused inconvenience, loss of income (due to curtailments placed on local industries), and loss of revenues from expected industrial/ business growth. The recent death of a worker assisting in the site's cleanup activities again highlighted the danger associated with the site.

Generally, weakness in the laws became evident to the people of Kernersville with their battle to resume use of the water supply. The involved governmental officials relayed that they had found their past State regulations ineffective or inappropriate in dealing with the management of hazardous materials. Their laws had not given them authority to remove a waste until it became an imminent hazard. Under the laws prior to 1980, the Destructo/ Carolawn site was a storage site, rather than a waste disposal site. Therefore, the State's Solid and Hazardous Waste Division had no jurisdiction over the site. This site was covered under an air quality permit issued by the County; however, the pollution problem was that of water quality damage and endangerment. With each separate agency having its own jurisdictional limits, it was difficult for the agencies to respond quickly and effectively to the problems surrounding the site.

Some of the government officials who are involved with the Destructo/Carolawn incident believe that bureaucratic confusion could be overcome by giving authority to one agency and one individual to coordinate environmental affairs concerning air, land, and water. They believe that time delays and duplicated efforts could be avoided and the overall environmental quality enhanced.

SITE D REFERENCES AND BIBLIOGRAPHY

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APPENDIX 5-1

SITE D NEWSPAPER ARTICLES

Editorial Cartoon Reprinted By Permission Of Kernersville News

GREENSBORO DAILY NEWS

SUNDAY, JANUARY 27, 1980

Kernersville Divided On Reservoir Use

BY WILLIAM KEESLER
Daily News Staff Writer

KERNERSVILLE — Two and a half years after an estimated 30,000 gallons of chemicals spilled into Kernersville's water system, the town's main reservoir remains out of commission.

Residents are sharply divided over when, if ever, use of the approximately 50-acre lake should resume.

Debate on the question has become entangled in the town's politics and in the continuing struggle over an issue that has faced the town for years: Should Kernersville be a suburb — a bedroom community for surrounding municipal giants Greensboro, Winston-Salem and High Point? Or should it be a self-sufficient commercial and industrial community with an identity all its own?

The reservoir was contaminated on June 2, 1977, when thousands of gallons of chemicals flowed out of tanks at the Destructo Chemway Corp. waste disposal plant, down a hill and into a creek feeding into the lake. Vandals were blamed for turning the valves on the tanks.

The chemicals polluted the lake, killed thousands of fish and forced the temporary evacuation of 1,000 area residents. The town was forced to close the reservoir and begin buying water from the Winston-Salem/Forsyth County water system.

According to officials with the water supply branch of the N.C. Division of Health Services, the water in the reservoir has been tested periodically since and is now free of contamination. Carolawn Co., which took over operation of the site from Destructo, moved out of Kernersville in November and is now constructing a waste disposal plant in Fort Lawn, S.C., about 45 miles southwest of Charlotte.

When Carolawn moved, it left behind an estimated 50,000 gallons of chemicals in rusting 55-gallon metal drums. According to Charles Rundgren, head of the state water supply branch, the potential for further contamination exists.

State officials have recommended but say they do not have the power to require that the town keep the reservoir closed until the chemicals are removed. If the town begins using the lake sooner, it will have to bear the liability for any resulting contamination, Rundgren said.

Despite this warning, some Kernersville citizens want to use the reservoir immediately. On Dec. 4, reversing an earlier decision, the town Board of Aldermen voted 3-2 to disconnect from the Forsyth water system and hook back onto the lake.

This change of mind sent shivers of horror through other town residents. Morgan Culliton and his wife, Kay, filed a class-action suit seeking a permanent injunction against reopening the reservoir, charging that doing so would be "the first step in a perilous course to eventual catastrophe for both the city and its citizens."

Early this month, the board reversed itself again, voting 3-2 to postpone resuming use of the reservoir until after the chemicals are removed. But the class-action suit is pending.

At this time, the Cullitons and their attorney, John Stone, a leader in the opposition to the December board decision, want the reservoir closed for good, even if the chemicals are removed. While the water could be used for industrial purposes, they say, it should not be allowed for human consumption.

Stone believes Kernersville could become another Love Canal — the New York catastrophe of the mid-1970s in which people began having miscarriages and other health problems after building homes on top of an old chemical waste dump. He contends the Kernersville reservoir still may contain undetected chemicals that could be stored in the body fat and reappear in 10-20 years in the form of cancer and other serious illnesses.

(See Residents: B-4, Col. 1

Residents Sharply Divided

From B-1

Chemicals still could be in the floor of the reservoir, he said, and they have seeped into the soil of the disposal site, creating a potential runoff problem. Stone said he has been told some of the fish killed in the 1977 spill are buried in the watershed, raising another possibility of contamination. He and Culliton also fear that a creekside landfill at the metal recycling plant beside the waste disposal plant site could cause further problems.

"This scares the hell out of me," said Culliton. "I don't see how they can say it's safe. They just don't know."

"We don't know exactly what chemicals went in there," said Stone, 31, a Kernersville resident with a wife and a child. "When chemicals get together, they form compounds. The reactions can vary. Nobody knows what compounds were formed.

"If there's one chance in a million that there's something harmful out there, then I don't think we should take that chance of hurting our families and our friends."

Officials of the state water supply branch said tests of the reservoir bottom have shown no contamination problem. According to Roy Rettinger, a state environmental engineer based in Winston-Salem, preliminary results from a recent test just downstream from the recycling plant landfill showed no runoff problem there.

The state's solid and hazardous waste branch and the U.S. Environmental Protection Agency are now inspecting the waste disposal site to identify the remaining chemicals and determine how to dispose of them. Once the chemicals are identified, more water tests will be performed, said M.O. Caton of Winston-Salem, the water supply branch regional engineer.

The three aldermen who voted to reopen the reservoir in December say the water is safe to drink now. One of them, Larry Brown, went so far as to dip raw water out of the lake in late 1978 and drink it, passing it through a coffee filter only once for protection.

Brown, 36, who operates a local clothing outlet, swears he and his dog drank about 25 gallons of the stuff during a period of several months, with no noticeable ill effects.

"We feel like we have one of the best-quality water supplies in the Southeast or the nation," Brown said. "Even despite the chemical spill, we have a good-quality water."

He said that since the spill a dike and other safeguards have been provided at the waste disposal site that will prevent the remaining chemicals from causing further contamination.

Brown helped lead the campaign against a town proposal in 1978 to issue $1.2 million in bonds to finance a permanent hook-up to the Winston-Salem/Forsyth County system. The referendum was viewed as a battle between those wanting to control the growth of the town (Brown's group), and those wanting an increased supply of water to recruit new industry (a group unofficially headed by Mayor Roger Swisher). Inextricably bound up in the fight was the stricken reservoir. The bond proposal failed by a substantial margin.

"There are some people in the city who want a no-growth policy," said Swisher, 49, a local car dealer. "They figure that if you don't have any water, the city will stagnate. It can't grow.

"If Kernersville is going to stay a strong and independent community, we're going to have to grow. We can't stand still. We'll be swallowed up by the communities around us."

Brown's group, however, maintains it opposes only uncontrolled growth. They say Kernersville should seek clean industries, like product distribution centers, instead of heavy manufacturing operations that would use large amounts of water.

The group also strongly resists the idea of ceding to the county the responsibility of supplying water. According to Alderman Larry Cain, another who voted for reopening the reservoir in December, the town already has given up too much.

"If they've got our sewage, they've got our water, they've got our schools, they've got our library, they've got our YMCA, what else does the town have other than garbage collection?" said Cain, 37, a local funeral home director. "And we could have a private garbage service take that. If we give everything we've got away, then I think we've lost our identity as a town."

Alderman Inez Davis cast the deciding ballot in both the December and January board votes. Davis, 49, a substitute schoolteacher, voted for reopening the reservoir in December, she said, because among other reasons, after two and a half years nobody — the town, the state, Carolawn or Carolawn's landlord, Brenner Industries of Winston-Salem — had done much about the problem. She voted against in January, she said, because finally it appeared action had started.

The state solid and hazardous waste branch and the EPA have entered the controversy since the first of the year. O.W. Strickland, solid and hazardous branch head, said identifying and disposing of the chemicals probably would be a "rather slow process." There is no disposal site available in North Carolina.

Officials for Brenner, Carolawn and the town held a negotiating session last week. Swisher said afterwards that Brenner is negotiating a contract with Carolawn to remove the remaining chemicals. He said he is hopeful that the chemicals can be removed by the first week in March and that the state can then come in for final testing.

Telephone calls to Carolawn and to Brenner, which also is the operator of the metal recycling plant next door to the waste disposal site, were not returned.

Besides the matter of the chemicals, there still is considerable litigation to resolve. Kernersville has a $1.5 million suit pending against Carolawn and Destructo Chemway, and the state recently filed a $24,500 suit against Destructo and its president, David M. Neill of Charlotte.

"Law, there were times I thought we would never get anywhere," Davis said. "Now it looks like we're finally getting somewhere. But I won't believe it until I see it."

A Little Watergate!

Letter to the Editor:

Do we have a little Watergate going on in Kernersville? Why all the secrecy about our water situation?

When was it decided that our water plant was really in need for substantial renovation or replacement? How long has this been in the making? It's been in the making for a long time, or it would seem so.

A group of engineers set up office in Kernersville and a temporary water line was laid prior to the chemical spill at Destructo in June of 1977. Who hired these engineers to whom we owe a substantial debt of $120,000? Was it the town manager or the aldermen?

If our system was in such a rundown condition, why did our officials spend $100,000 on a parking lot? Would you call this good planning for the future of the citizens?

I suggested to some of our aldermen a long time ago that I and others would rather pay a substantial increase in our water rates if we could use our own "clean, spring-fed lake" rather than the Yadkin River for our water supply.

But this wouldn't be good for a big industry boom or large developments, would it?

Since we are required to operate our utilities on a self-sustaining, enterprise system, why can't we, with the population we have of over 7,000? We've had this large population for sometime now and it's just come to light that this utility must pay for itself and that it has not done so for the past four years. Very interesting!

Yet we keep on annexing, overloading our water, sewer lines and streets. Good planning!

This was one way of phasing out our present water plant, of which we do have sufficient water for the next 10-15 years.

If we go to city-county water, and that's exactly where we're going, then we can expect to be the first cut off if any malfunctions or water shortages occur in the future. This is exactly what happened last summer.

Going to county water would really help Kernersville to have a big industry boom and development would really blossom, and that's what it's all about.

Come on, citizens, wake up!

Because of poor planning, "power," and "what I want" rather than what's best for the citizens, we have a clearer picture of why we have insufficient sewer lines and streets.

When our clean lake is closed for our water supply, I wonder who stands to gain from this move? Who will profit? Who is really interested in our lake? A great recreation center, you might say. If the water isn't suitable for us to drink, then would we be allowed to eat fish that are caught from it?

Since the mention of fish comes to mind, I wonder why the fish did not die downstream from the lake during the oil spill that supposedly killed the fish in the lake? Oh yes, why did the fish die first at the opposite end of the lake after the oil spillage?

A meeting has been scheduled for Monday, Feb. 13, at 6:30 p.m. in the Paddison Library to hear from citizens who depend on the town for their water supply, to find out whether or not they want to again use the clean lake for our water supply or go to county water.

Call your aldermen and let them know how you feel about this situation. They are Larry Brown, Max Coltrane, David Holt, Aubrey Morris and Ivey Redmon.

Our mayor said at the last Board meeting that Mr. M. O. Caton, of the North Carolina Department of Human Resources, would be present at this meeting. Will he? If so, come and bring your questions to the man who has declared our lake safe for drinking, and to the engineers who have been the town's advisors in this situation and have given our aldermen several alternatives to take.

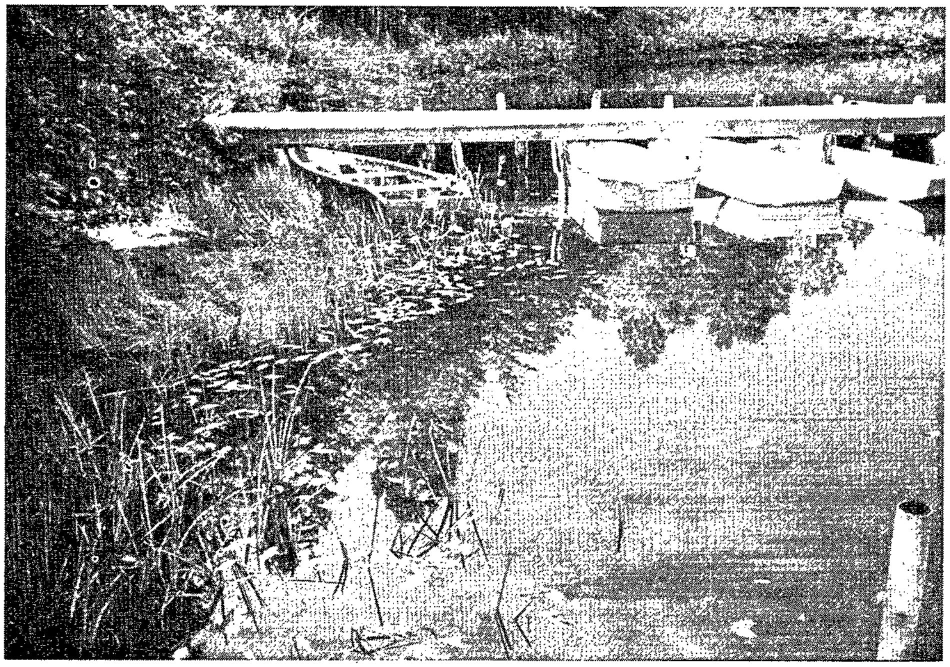
I have said several times and I will say again that I would like to use our lake again as a water supply and use the county water as a backup source.

We have asked that a clipping be run in this week's Kernersville News asking whether the citizens of Kernersville would like to use our lake again as our primary water supply or go to county water.

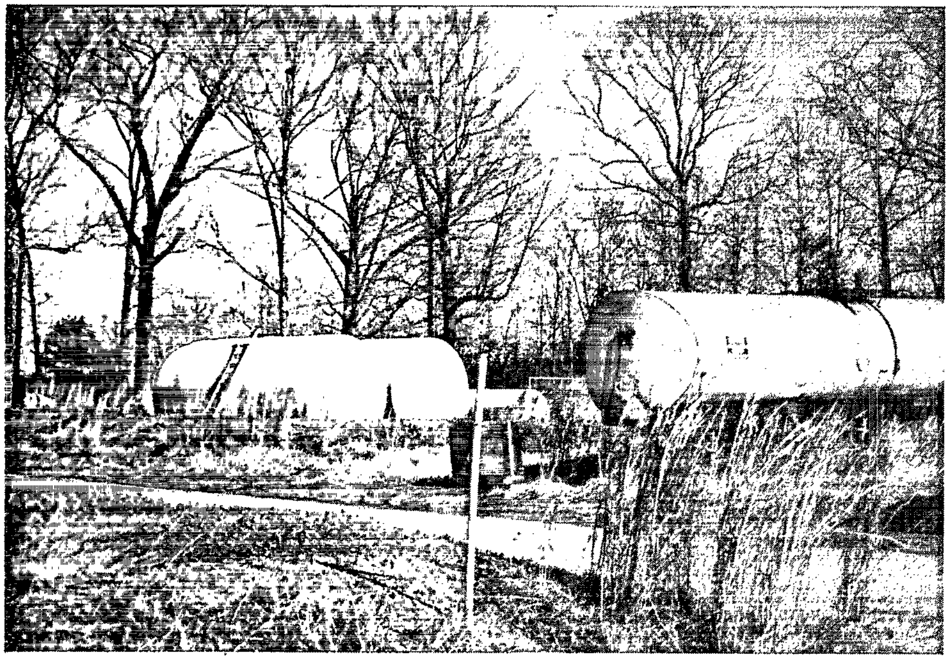
If it is run, please sign your name and state the reason why you would or would not be in favor of this move and return it to the newspaper before Feb. 13.

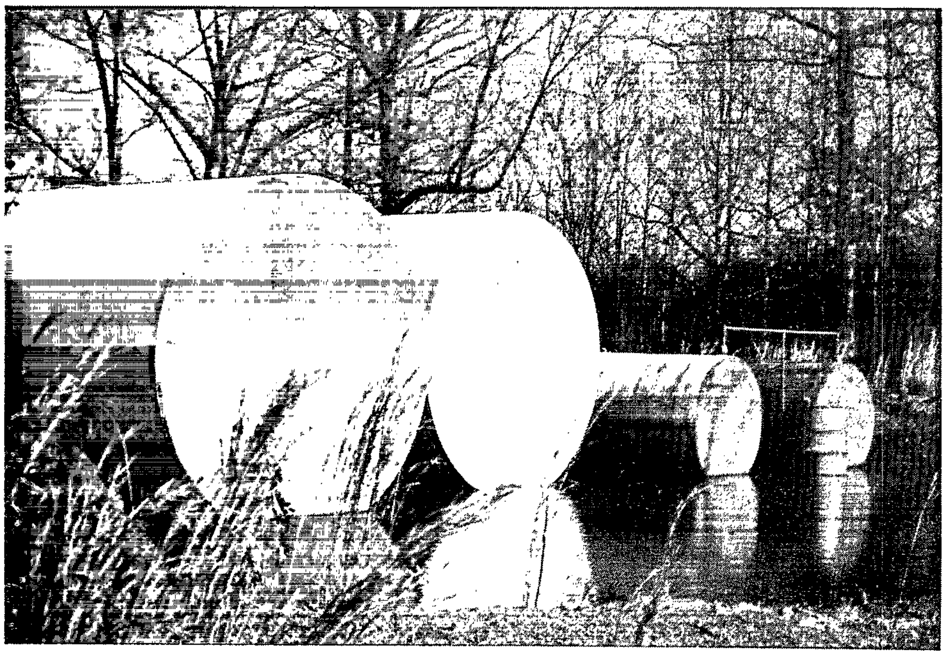
APPENDIX 5-2

SITE D PHOTOGRAPHS



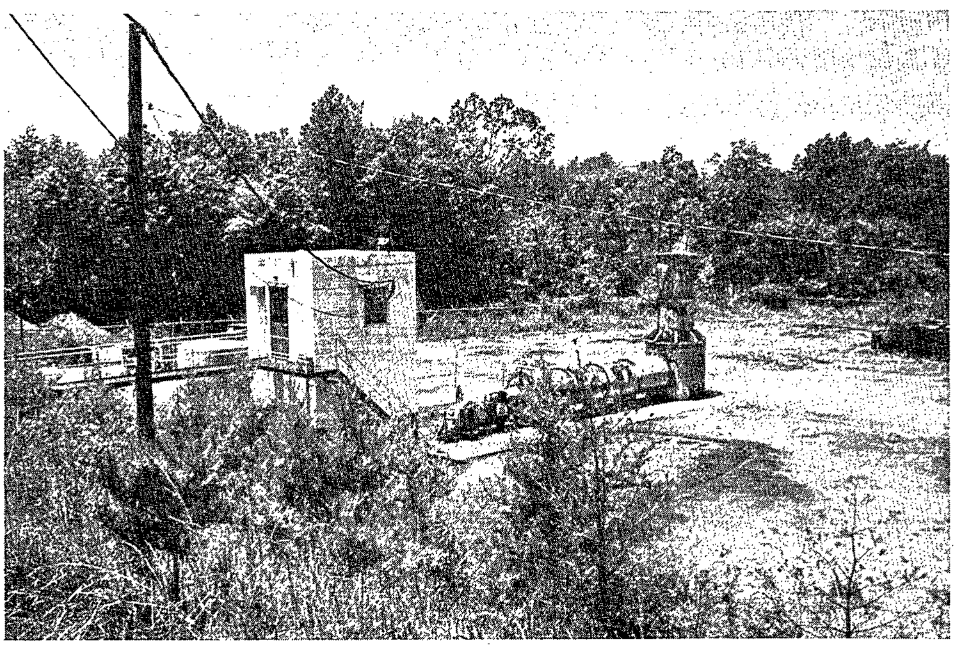
As a result of the spill in 1977, more than 90 percent of the fish in Kernersville Lake died (top photo). The fish were gathered, removed from the Lake, and placed in barrels (bottom photo).



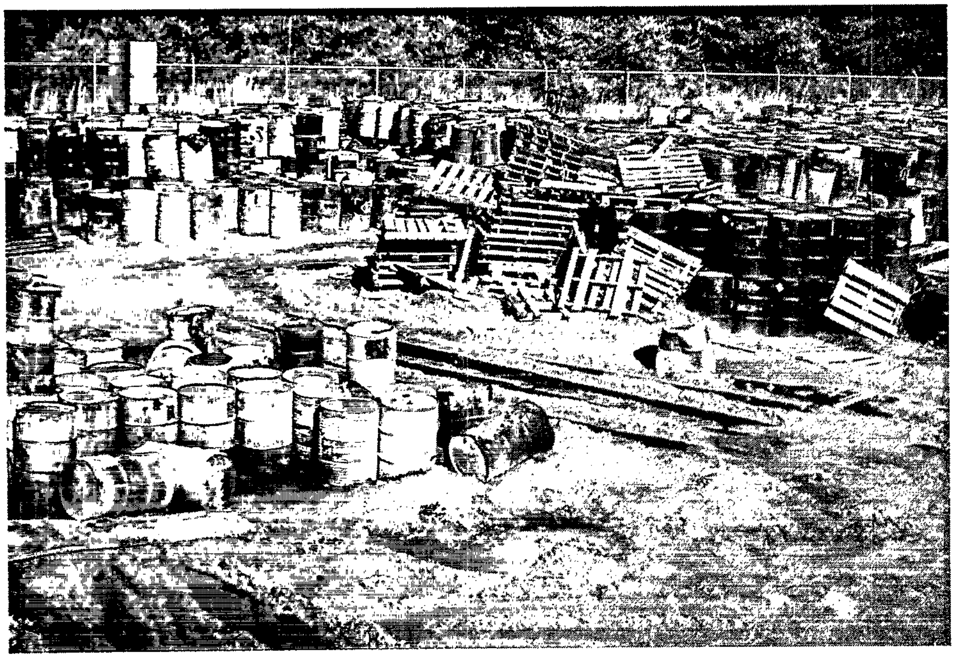


Berms (top photo) were placed around the tanks following the 1977 spill. By March 1980 pools of water had collected in the bermed area around the tanks (bottom photo).

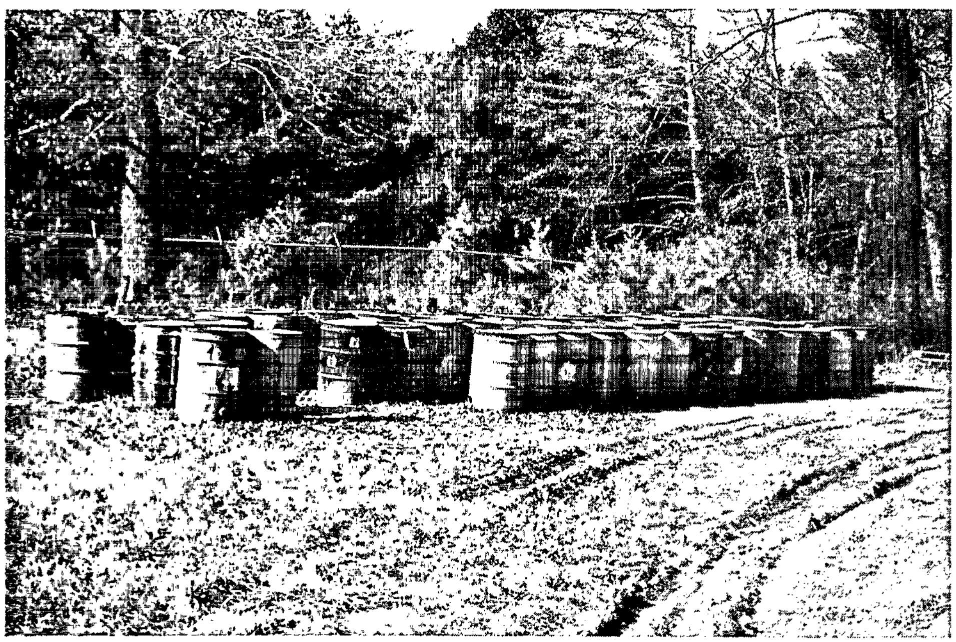
Dead fish and contaminated soil and debris were placed in a limed, lined pit at the Destructo/ Carolawn site in 1977.



This incinerator was used by Destructo prior to the spill of June 1977. Carolawn reportedly only used the site as a storage and transfer station, and did not use the incinerator.



As evidenced by the photo of March 1980, the site was poorly managed by Carolawn, the successors to Destructo.



After Carolawn vacated the site, initial cleanup activities were implemented by the landowner, Brenner. One of the first steps was to segregate the waste according to characteristics.

SECTION 6

SITE E
WHITMOYER LABORATORIES
MYERSTOWN, PENNSYLVANIA

INTRODUCTION

Whitmoyer Laboratories, Inc. has operated an animal pharmaceutical manufacturing facility in Myerstown, Pennsylvania since 1934. In July 1964, they became a subsidiary of the Rohm and Haas Company of Philadelphia. Rohm and Haas sold Whitmoyer Laboratories in early 1978 to Beecham, Inc., but Whitmoyer Labs has retained its identify as a separate company.

When Rohm and Haas purchased Whitmoyer Labs in 1964, extensive arsenic contamination of the soils, ground water, and a nearby stream became apparent to Company officials. Emergency remedial actions were taken to stop further contamination and to remove the contamination that existed. Ground and surface water studies were conducted and a ground water monitoring, extraction, and treatment program initiated which consisted of three parts: clean-up and recovery; development of cones of depression; and stream and well monitoring.

Actions to remove arsenic from the ground and surface waters have been fairly successful. However, insoluble arsenic remains in the soils and ground water of the facility and the sediment of the creek. These levels are expected to slowly decline.

SITE DESCRIPTION

Whitmoyer Labs is located on North Railroad Street in Myerstown, Pennsylvania. Myerstown is located between Harrisburg and Reading, Pennysl vania, approximately 95 km (60 mi) northwest of Philadelphia.

The normal annual precipitation for the area is 110 cm (44 in.) and is distributed fairly evenly year round. Snow fall averages 90 cm (35 in.). The average wind is 12 km/hr (7.7 mi/hr). The average temperature is 11°C (53°F) with the highest daily maximum of 24°C (76°F) occurring in July and the lowest of -1°C (30°F) occurring in January.

The facility lies adjacent to Tulpehocken Creek 60 km (37 mi) upstream from its confluence with the Schuylkill River and about 25 km (16 mi) upstream from the upper end of the Blue Marsh Dam Project (see Figure 6-1). Myerstown is situated

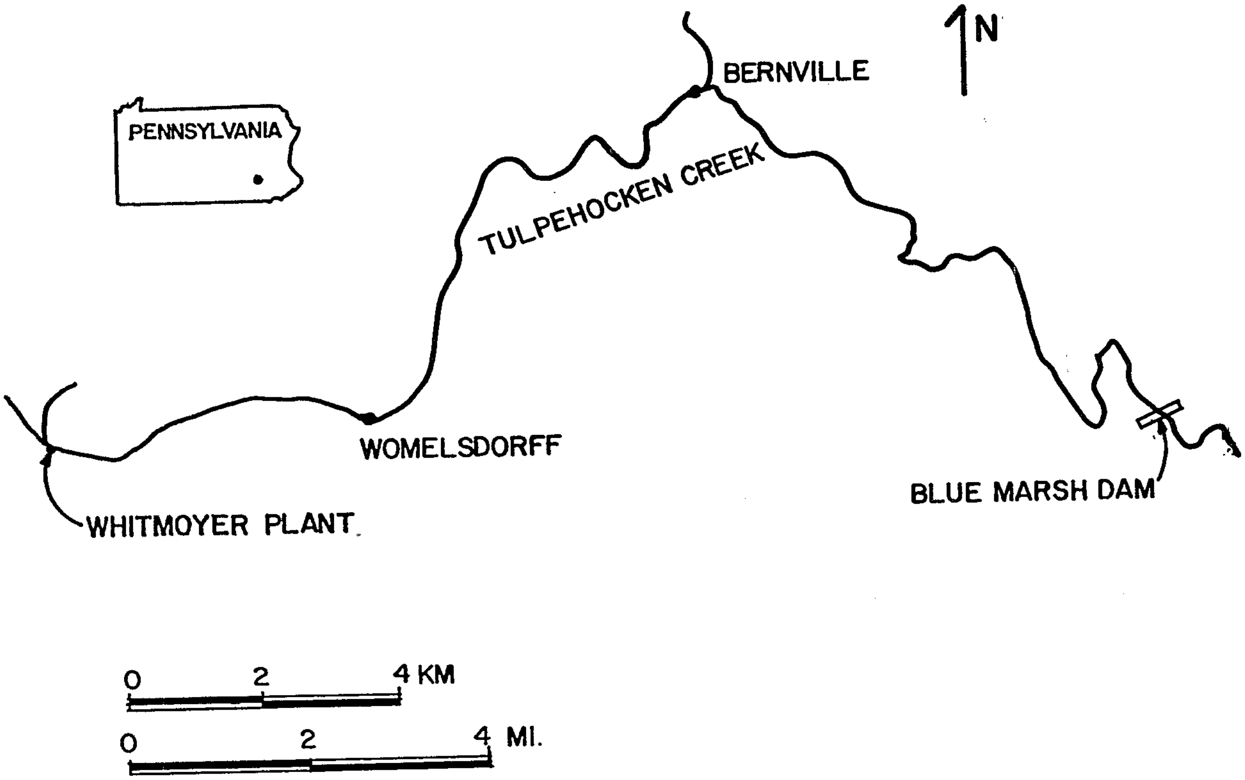


Figure 6-1. Location of Whitmoyer Labs [6-1]

a few miles upstream of Whitmoyer Labs. Womelsdorff is the first town downstream at approximately 6 km (4 mi). There are some farms, which use the local ground water, located nearby on both sides of Tulpehocken Creek. A 45 m (150 ft) deep calcite quarry lies 2.4 km (1.5 mi) west of Whitmoyer Labs.

There are several buildings on-site used for production and administration (see Figure 6-2). The old lagoons are covered and there is a temporary storage building situated on one part and a Buckeye pipeline pumping station located on another part of the lagoons. There is also a 25 m (83 ft) by 37 m (123 ft) by 3.6 m (12 ft) high concrete vault on site which is completely filled with arsenic wastes. A cooling canal flows through the property beginning and ending in the Tulpehocken Creek.

The drainage basin of the Tulpehocken Creek covers 550 km^2 (211 mi^2) and is 54 km (33.5 mi) long. The average and minimum flows at the confluence of the Tulpehocken Creek with the Schuylkill River during Septemberand October 1964 were 1.6 cms (58 cfs) and 1.5 cms (56 cfs), respectively. The average annual flow for the creek is approximately 5.7 cms (200 cfs) and the maximum flood flow was 200 cms (9,890 cfs) on December 7, 1953. The general direction of the stream follows the east northeast strike of the carbonate bedrock. The ground water found under Whitmoyer Labs is potable and used by local residents and farmers. There are some artesian wells found nearby but the static water level in most wells lies near the ground water table.

Whitmoyer lies close to a ground water divide in a system of limestone aquifers underlying the Lebanon Valley. Prior to the industrialization of the Lebanon Valley area, the natural ground water divide was probably conformable to the present topographic divide which lies between the headwaters of Tulpehocken Creek and Quittaphalla Creek, about 5 km (3 mi) west of the plant. A calcite quarry, located 2.4 km (1.5 mi) to the west of Whitmoyer, has pumped ground water from the bedrock aquifers while continuing quarry operations. This has shifted the ground water divide east so that it is now located just to the west of Whitmoyer as seen in Figure 6-3.

The position of the ground water divide determines the flow direction of wastewater produced by Whitmoyer. This wastewater has been a source of recharge to the local ground water aquifer for several years. The majority of the flow moves east but some pollutants which originated from the plant have been found to the west. Figure 6-3 shows the ground water level contours at the plant on July 23, 1973. Ground water flow was to the northeast to a ground water trough coinciding with Tulpehocken Creek. There is another ground water divide east of Womelsorff (see Figure 6-1) which interrupts the flow down valley. Therefore, no arsenic wastes reach Blue Marsh Lake via the ground water.

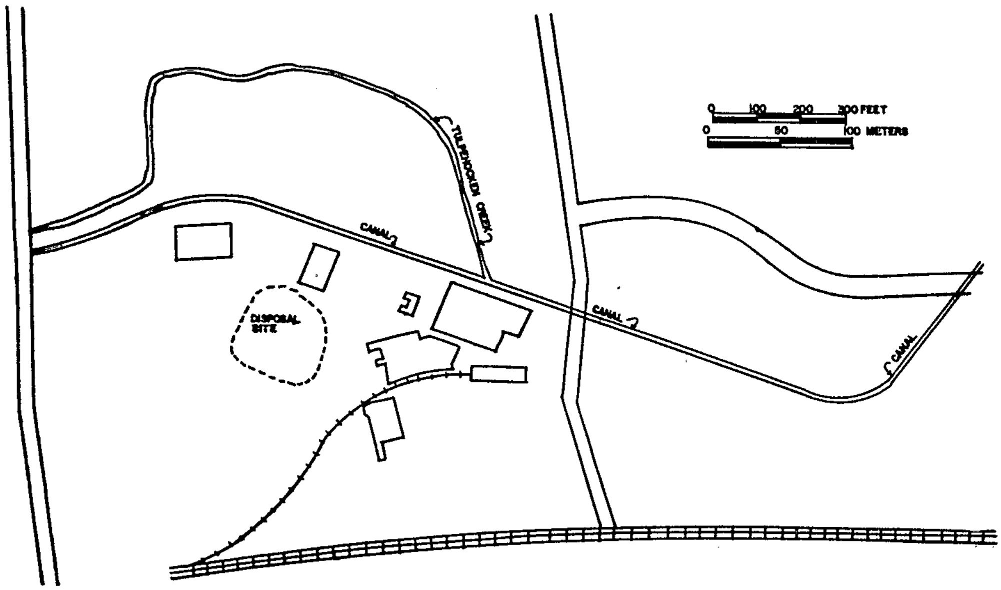


Figure 6-2. Detailed site location for Whitmoyer Labs. [6-2]

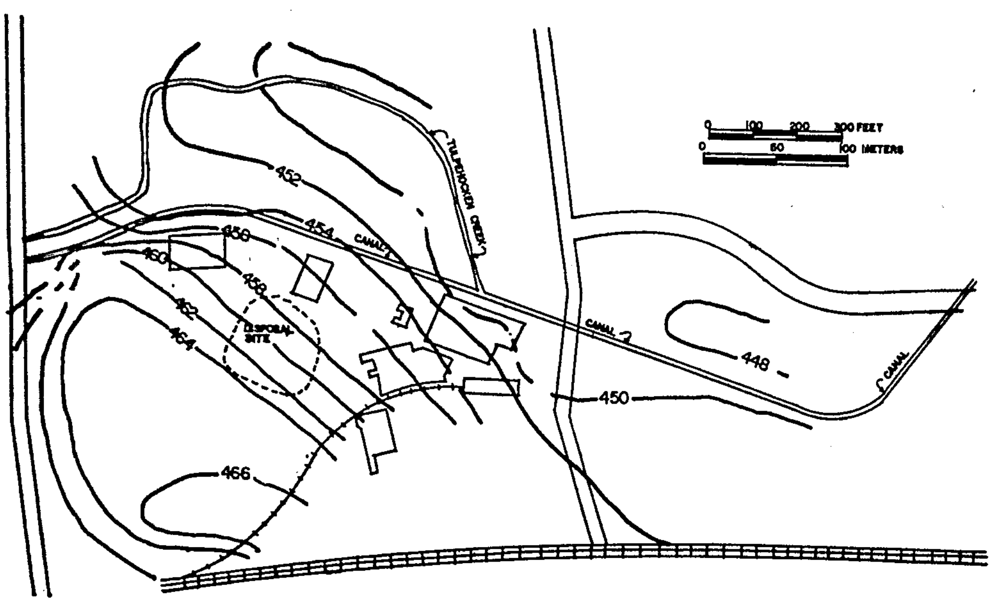


Figure 6-3: Ground water contour map for Whitmoyer Labs. [6-2]

The bedrock under the plant consists of limestones and dolomites which strike east-northeast and exhibit a dip of 30 degrees to the southeast. Whitmoyer lies directly over the Ontelaunee Formation (dolomite) which is approximately 275 m (900 ft) thick (see Figure 6-4). Underlying the Ontelaunee, and surfacing about 460 m (1,500 ft) north of the plant, is the Annville Formation (high calcium limestone). The Epler Formation (a dolomite not present at the plant) overlies the Ontelaunee surfacing about 130 m (425 ft) south of the plant. The Hershey Formation (a tight shaley, silty limestone) underlies the above formations and, together with the Epler Formation contains the ground water in the Ontelaunee and Annville Formations. Any cones of depression formed by purging wells will not be conical, but ellipsoidal in shape following fractures and solution channels in the rock.

The soil mantel averages 1.5 m to 2 m (5 to 7 ft) thick and is made up of alluvial sand, silt, and gravels. It is fairly permeable and allows for rapid recharge to the bedrock aquifers. The area has a gently rolling topogrpahy resulting from erosion by the Tulpehocken Creek and its tributaries. The valley walls to the north slope upward from the creek's elevation of 140 m (450 ft) at the site, to 150 m (500 ft) in 1 km (0.6 mi). To the south it is steeper, reaching 150 m (500 ft) in 0.5 km (0.3 mi).

The area near the Whitmoyer site is predominantly farmland. It is used for grazing and crops. Deciduous trees are found along water courses and on hillsides. The Whitmoyer site is vegetated with short grasses and a few outlying trees.

SITE OPERATION AND HISTORY

Whitmoyer Labs employs approximately 100 people and manufactures a diverse line of pharmaceutical and nutritional products for the poultry, livestock, and feed industries. These products include sulfur compounds, vitamins, antibiotics, feed additives, and supplements based on arsenic chemicals. In 1963, Whitmoyer's consolidated sales totaled nearly $9,000,000. Their products are sold over the counter, not distributed through veterinarians. Some of their major products include:

1. Arsanilic Acid - used to prevent dysentery and promote growth in swine.

2. Biodin and Ethylenediamine Dihydroiodide (EDDI) - used to prevent foot rot in cattle and used as a source of iodine.

3. Piperazine - used as a low cost dewormer for chickens, turkeys, and swine.

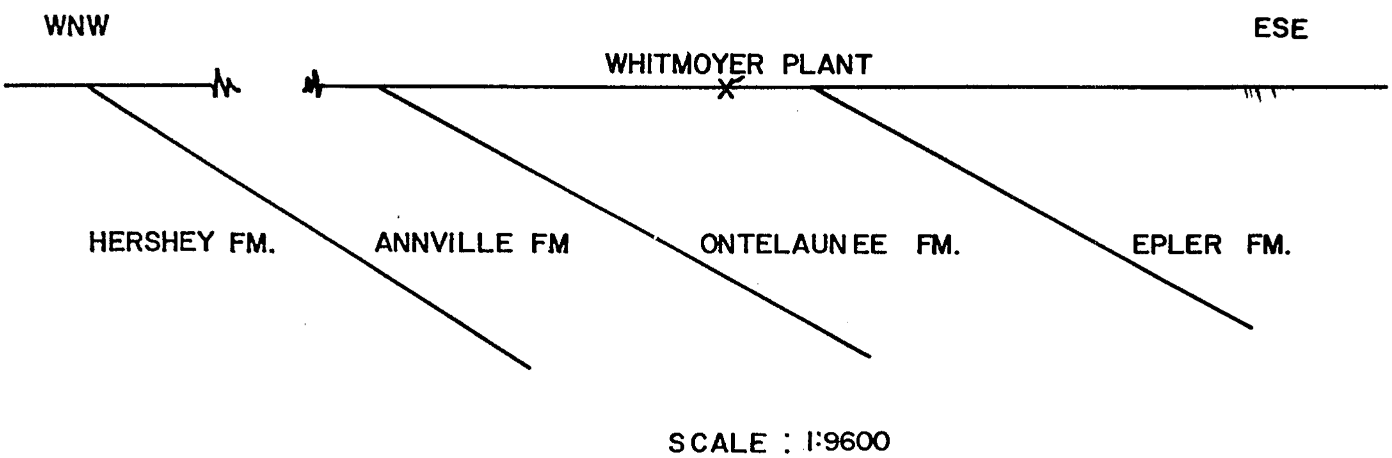


Figure 6-4. Generalized geologic cross section drawn perpendicular to the strike direction.

4. Carb-O-Gain and Carb-O-Sep - used to prevent black head and promote growth in turkeys.

Whitmoyer also packages and labels their products for shipment.

Whitmoyer Labs was founded in September 1934 when Mr. C. W. Whitmoyer's firm merged with a similar pharmaceutical company. Whitmoyer began production of arsenic compounds at Myerstown in 1959.

The wastewater generated by their manufacturing plant was treated with lime and handled as a slurry for disposal in an unlined lagoon. The arsenic wastes were primarily organically bound arsenic compounds (arsenical compounds), calcium arsenate, and calcium arsenite. A total of about 450,000 kg (1 million lbs) of waste was lagooned. The plant's sanitary sewage and other non-arsenic bearing wastes are discharged to the Myerstown Sewage Authority Treatment Plant.

In July 1964, the Rohm and Haas Company, a Philadelphia based chemical company, bought Whitmoyer Labs. Although Whitmoyer became a wholly-owned subsidiary, it retained its former managerial staff.

POLLUTION AND REMEDIAL ACTION

The arsenic pollution problem was first identified by Thomas Iezzi of Rohm and Haas in September 1964. Ground and surface water in the vicinity of Whitmoyer Labs was found to have been affected by the arsenic wastewater production. Therefore, on-site treatment and disposal practices were discontinued in December 1964. The ensuing recovery and rehabilitation program consisted of three phases: (1) clean-up and recovery, (2) development of cones of depression, and (3) stream and well monitoring.

At this time, four wells began purging ground water containing the arsenic compounds. Subsequently, the Rohm and Haas Research Department perfected a treatment process to remove the arsenic from the purged water in the form of insoluble precipitates. They added ferric sulfate at the ratio of approximately two parts ferric sulfate to one part arsenic, and adjusted the pH to neutral conditions by adding lime. This process reduced the arsenic content from more than 2,000 ppm to 1 ppm. All the recovered water was handled in alternating batch mixing tanks on a continuous feed treatment schedule and sent to the lagoons to dissipate via slow percolation to the subsoil.

Yields of extracted arsenic peaked at 5,000 kg (11,000 lbs) per week, later leveling off at about 2,000 kg to 2,300 kg (4,500 to 5,000 lbs) per week by April 1965. The water from the contaminated aquifer initially contained 10,000 ppm arsenic. After 400 m^3 (100,000 gal) of ground water was pumped, the arsenic level dropped first to 6,500 ppm, and then to 100 ppm.

Early in 1965 sludge was removed from the lagoons as well as the contaminated soils underlying the lagoons. These materials were deposited in an impervious concrete bin 43 m (123 ft) long, 25 m (83 ft) wide, and 3.5 m (12 ft) deep. The bin was filled to capacity and covered. Three additional purging wells began operations in early 1965. Approximately 450 m^3 (120,000 gal) per day of wastewater was treated, and about 200,000 kg (400,000 lbs) of arsenic compounds were purged and treated. The plant was reopened in the spring of 1965 on a no-discharge basis. They began trucking treated wastes to a holding area in New Jersey to await ocean dumping.

The second phase (entailing development of cones of depression via counterpumping) began as the arsenic recovery rates from the seven wells continued to decline. By the end of 1966, 23 new wells had been drilled. These original seven wells and seven of the new wells were then used as production wells to form cones of depression east of the plant. Ten of the remaining wells were used for observation, five were abandoned, and one later used to replace one of the original seven purging wells. Arsenic concentrations in water from the new extraction wells ranged from 33 ppm to 440 ppm. The increased rate of arsenic removal is seen with the addition of seven wells:

- Initial 7 wells - 28 kg/day (62 lbs/day) arsenic
- Initial 14 wells - 44 kg/day (97 lbs/day) arsenic.

The well locations may be seen in Figure 6-5. Table 6-1 indicates the well number, well depth, amount of water pumped initially, and the arsenic concentration present at the time of completion.

Whitmoyer Lab's production rate was partially dependent on its purging rate and the development of the cones of depression. Nearly all of the liquid extracted from the ground was returned. Natural precipitation also contributed to the recharge adding to the aquifer's volume. The cones of depression were developed to stop the migration of the ground water. Therefore, as the volume of the aquifer contained by the cones of depression grew, it became more and more difficult to maintain the existing cones of depression. With the addition of the seven new purging wells, the cones of depression were initially increased and Whitmoyer Labs could increase their production rates.

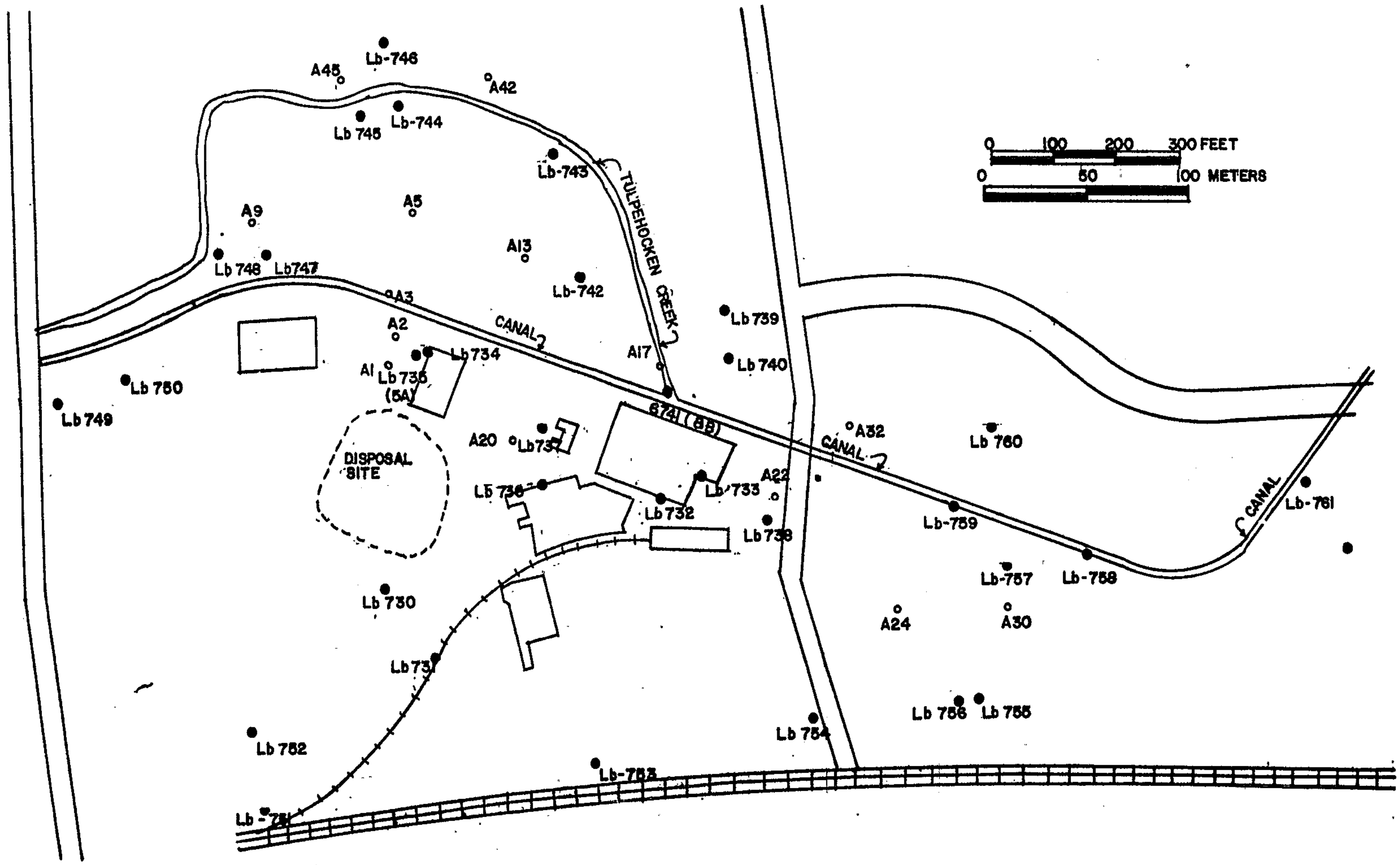


Figure 6-5. Location of wells on Whitmoyer Labs property. [6-2]

TABLE 6-1. INITIAL ARSENIC CONCENTRATIONS FROM PLANT WELLS

Well No.	Depth (m)	Extraction Rate (m^3/min)	Arsenic Concentration (ppm)
5-A	48	0.036	326
9	29	0.150	155
9-A	30	0.190	102
10-A	30	0.098	440
11	30	0.045	349
16-B	37	0.038	146
17	21	0.303	297

1 m = 3.28 ft
1 m^3/min = 264 gpm

The treatment of the ground water continued until late 1968 when Whitmoyer Labs began to discharge the purged water directly to Tulpehocken Creek. Permission to do so was granted by the Delaware River Basin Commission. By December 1968, direct discharge of the total amount of purged water to the Creek had been attained. The discharge rate of all 14 wells increased to 950 m^3/day (250,000 gpd) and then dropped as the cones of depression began to expand. Direct discharge to the Creek ceased in April 1969 but resumed in September of the same year.

Early in 1971 there was a public outcry against the dumping of arsenic in both the Atlantic Ocean and local surface waters. Rohm and Haas ceased operation of their purging wells and of their discharge to Tulpehocken Creek. The cones of depression never developed to their full potential, but they did contribute to an improvement in conditions. Approximately 22,000 kg (50,000 lbs) of arsenic was recovered and disposed of during the second phase. But there probably was a considerable amount of arsenic waste carried ultimately to the Atlantic Ocean. Runoff and ground waters which contained arsenic flowed to Tulpehocken Creek which flowed to the Schuylkill River to the Delaware Bay.

There were two forms of arsenic wastes involved in Whitmoyer Labs ocean dumping: solids and liquids. Only 0.5 percent of the arsenic found in the liquid waste was trivalent (which is considered toxic). The balance, including solids, was pentavalent. In March 1971, Whitmoyer Labs produced approximately 1.4 million kg (3 million lbs) of liquid wastes per month. This included mother liquids from the Arsanilic Acid and Carb-O-Sep crystallization process. The components were as follows:

Component	Value
Organic arsenic (Arsanilic Acid)	2.43%
Inorganic arsenic (H_3AsO_4)	5.82%
Arsenite (toxic)	0.59%
NaCl	13.20%
Water	77.96%
pH	5.90
Specific gravity	1.166

Whitmoyer sent nearly 18,144 kg (40,000 lbs) of waste per day to a 3,700 m^3 (1 million gal) holding tank in New Jersey to await ocean dumping. Approximately 1,900 to 3,400 m^3 (500,000 to 900,000 gal) of wastes were dumped by ship on one trip.

Solid wastes produced and ocean dumped included tar-like aniline still bottoms, and carbon filter cake produced from the Arsanilic Acid clarification filters. The content of the aniline still bottoms was as follows:

Component	Content
Arsenic	12-13%
Aniline (free and combined)	30-40%
TTAA	25-35%

The arsenic is in a tightly bound molecular form. Aniline degrades rapidly but should not have migrated rapidly into the sea water while present in the still bottoms. [6-3]

In March 1971, Representative Charles W. Sandman (New Jersey) filed a civil action in U.S. District Court against:

- Pennsylvania Department of Environmental Resources, Industrial Waste Division.
- Pennsylvania Department of Health.
- Whitmoyer Laboratories.
- Rohm and Haas Company.
- Norton Lilly and Company (a shipping agent).

A temporary restraining order prohibited further ocean dumping.

The third phase of the recovery and rehabilitation program (stream and well monitoring) began after the discontinuation of the counterpumping. Quarterly monitoring of existing wells and of Tulpehocken Creek helps to identify the arsenic levels. Since 1972, the wastewater has been reduced in volume via evaporation (boiling), centrifuged, and drummed. The waste is then shipped to a secure landfill in New York State. Totals of the drummed wastes and by-products of the arsenic process for 1978 and 1979 are as follows:

	Number of Drums	
Drum Contents	1978	1979
Arsenic salt	1,778	1,573
Arsenic carbon	681	734
Arsenic Tar	84	85
Total	2,543	2,392

The U.S. Army Corps of Engineers began sampling surface waters which would feed their proposed Blue Marsh Lake early in the 1970's. Figure 6-6 shows the location of sampling stations that the Corps established along Tulpehocken Creek. They found the following arsenic concentrations in samples taken from September 1971 to August 1972:

- Tulpehocken Creek Water
  - Near Blue Marsh Dam

    Total arsenic = 0.03 ppm (range = 0.01 to 0.062 ppm)

    Inorganic arsenic = 0.01 ppm
  - Near Whitmoyer Labs

    Total arsenic = 0.088 ppm (range = 0.03 to 0.18 ppm)

    Inorganic arsenic = 0.04 ppm
- Tulpehocken Creek Mud
  - Near Blue Marsh Dam

    Total arsenic = 43 ppm
  - Near Whitmoyer Labs

    Total arsenic = 152 ppm

The following gives the arsenic content found in several wells drawing ground water at the Whitmoyer site:

Date	Well No.	Total Arsenic (ppm)	Inorganic Arsenic (ppm)	Trivalent Arsenic (ppm)	Organic Arsenic (ppm)
5/72	7	370	224	115	146
7/72	5	124	126	--	--
7/72	7	412	280	150	132
7/72	9	66	49	--	--

Figure 6-7 shows the seasonal changes in arsenic concentration found in Tulpehocken Creek waters. Higher contents of total arsenic occur generally with higher stream flows. The organic arsenic decreased in the winter months. In October 1975, wastewater containing about 2 kg (4 lbs) or less of arsenic was discharged accidentally into Tulpehocken Creek. Preventative measures to protect the creek from a similar accident were taken.

A plot of residual arsenic release in the vicinity of Whitmoyer Labs is asymptotic in a declining rate. The waters of Tulpehocken Creek contain less than 0.05 ppm arsenic and the arsenic contents in some private wells have dropped. Although arsenic compounds still remain in the ground water,

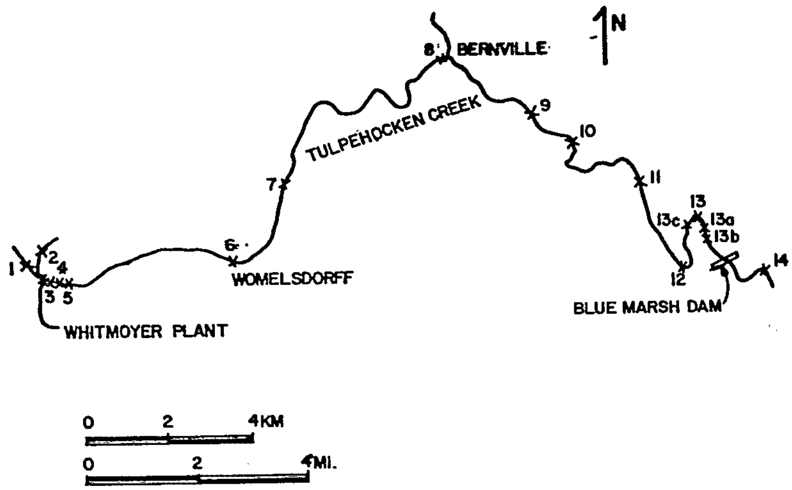


Figure 6-6. Location of sampling stations established by the U.S. Army Corps of Engineers. [6-1]

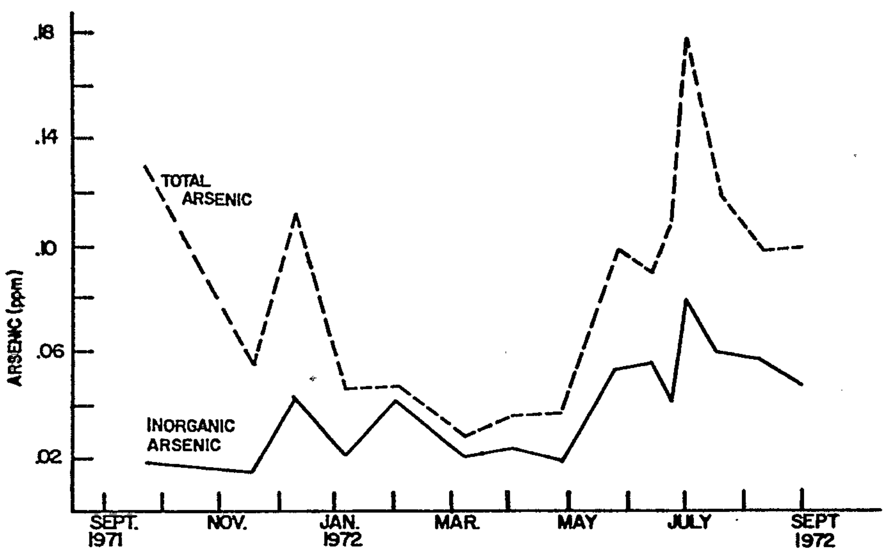


Figure 6-7. Arsenic content at Station 2 at Whitmoyer Labs. [6-2]

soil, and subsoil, a large amount has been removed or recovered.

CONCLUSION

Rohm and Haas has attempted, since their ownership of the Whitmoyer facility, to control the flow and reduce the amount of arsenic on and around their plant site (see Figure 6-8). The first phase of remedial action cleanup and recovery halted the production of arsenic wastes and removed quantities of sludge and contaminated soils. The plant was shut down until a process could be developed to remove arsenic from the wastewater. This phase eliminated the possibility of new arsenic compounds being added to the soils and subsequently to the ground and surface water.

The next phase (removal of arsenic from the ground water) was also largely successful. The recycling and treatment of the purged water did reduce the level of arsenic in the ground, and succeeded in controlling its movement. Little work was done to remove the arsenic from the mud and waters of Tulpehocken Creek since it would have involved the dredging of miles of creek bottoms and banks. Arsenic levels in the creek water have been brought under the limits set by the U.S. Department of Health and they continue to decline. Whitmoyer continues to supply bottled water to some area residents whose wells remain affected.

The third phase, monitoring, tracks arsenic levels to ensure that they do not increase, either through release of arsenic from bottom muds, or via spills from the plant. Remedial actions taken seem to have been the logical and effective response to limit and reduce arsenic contamination.

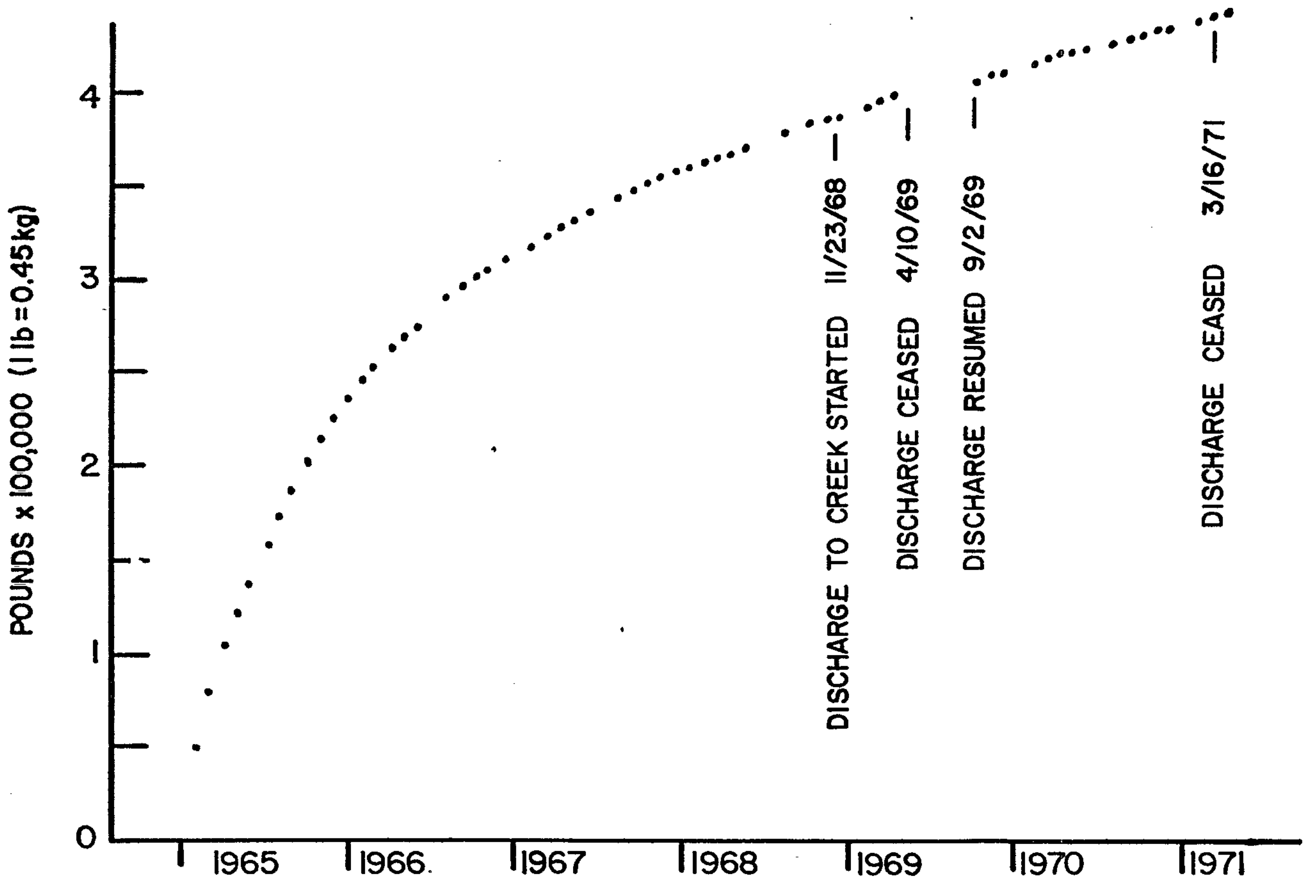


Figure 6-8. Cumulative graph of arsenic removed from the ground water at the plant site. [6-2]

SITE E REFERENCES AND BIBLIOGRAPHY

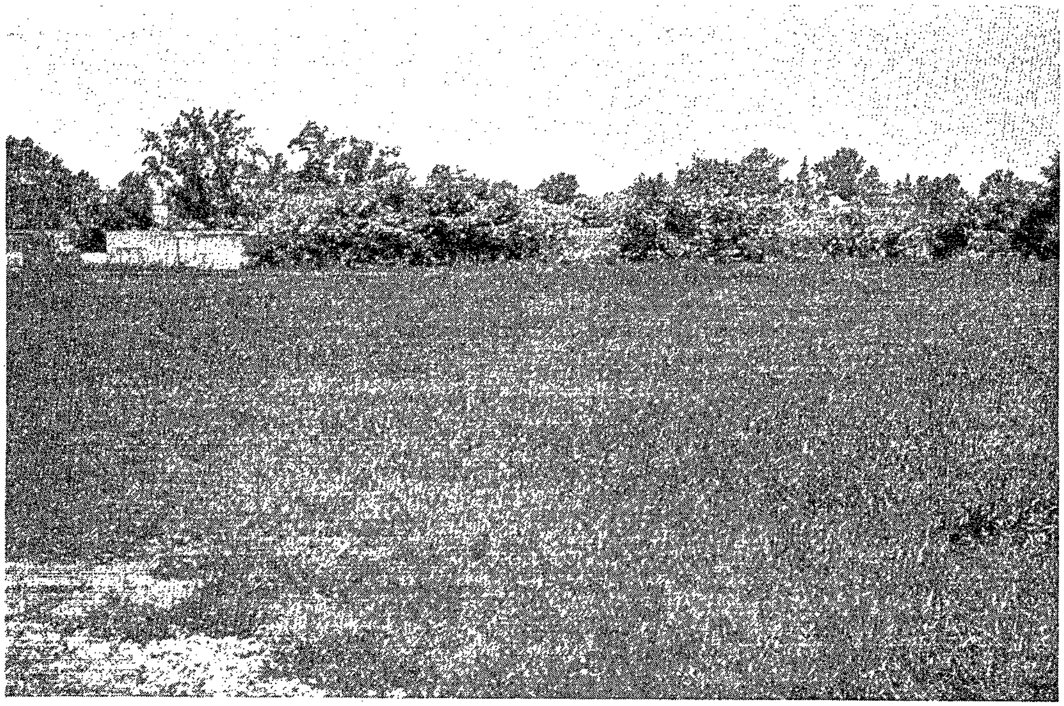
6-1 File Review at State Water Quality Division, Department of Environmental Resources, Harrisburg, Pennsylvania.

6-2 Wood, C.R., Evaluation of Arsenic Concentrations in Tulpehocken Creek Basin, Pennsylvania. U.S. Geological Survey.

6-3 Whitmoyer Laboratories. Description of Whitmoyer Laboratories, Myerstown, Pennsylvania. March 23, 1971.

APPENDIX 6-1

SITE E PHOTOGRAPHS



View of an old lagoon with final cover and vegetation.
The grass has had adequate time to become well established.

View of the Buckeye Pumping Station located atop an old lagoon.

SECTION 7

SITE F
WESTERN SAND AND GRAVEL
BURRILLVILLE, RHODE ISLAND

INTRODUCTION

Western Sand and Gravel is a hazardous waste disposal site located in northwestern Rhode Island. Waste disposal operations were initiated in 1975. Liquid septic and industrial wastes were transported to the site by municipalities and industries for disposal in pits where they were allowed to either evaporate into the air or percolate into the ground.

Since the start of operations, numerous complaints have been registered with the Rhode Island Department of Health (RIDOH). RIDOH attempted to close the site in 1977 but were unable to do so until 1979 when the Superior Court declared the existing guidelines, laws, and regulations governing disposal sites sufficient legal support.

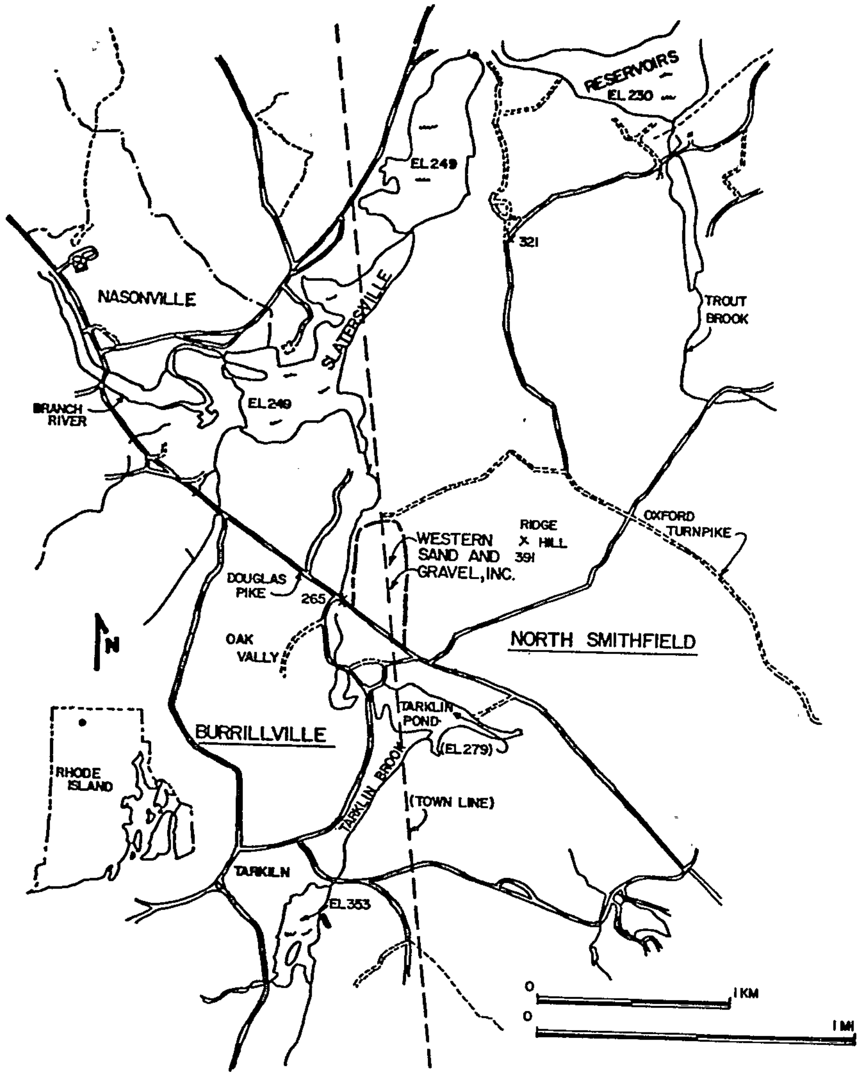
In February 1980, the U.S. Environmental Protection Agency (EPA) assumed jurisdiction over the site. Remedial work sponsored by EPA consisted of pumping liquid and solid wastes from four of the disposal pits and transporting them off-site. Solid residues from the cleanup are currently being stored at the disposal site in 0.2 m^3 (55 gal) drums and in a mound mixed with sawdust and covered with a polyethylene cover. The removal of septic wastes from other on-site disposal pits will commence in the near future.

A hydrogeologic study is currently underway to determine the extent of any ground water contamination. Work to date has shown that unless immediate action is undertaken the water supply down-gradient from the site will be permanently damaged forcing residents to find alternate water supplies. The total cost for such cleanup activities has been estimated at $1,000,000.

SITE DESCRIPTION

Western Sand and Gravel, Inc. (WS&G) is located in a sparsely populated section of northwestern Rhode Island, approximately 24 km (15 mi) northwest of Providence and 8 km (5 mi) southwest of Woonsocket. It is on the north side of Douglas Pike (Route 7), 2 km (1.3 mi) southeast of Nasonville in Burrillville, straddling the Burrillville-North Smithfield township line. The location of the site is shown in Figure 7-1.

The waste disposal area of the site is adjacent to the Company's sand and gravel operations. It consists of 12 in-ground



NOTE: All elevations in ft above mean sea level.

1 ft = 0.3 m

Figure 7-1. Location of Western Sand and Gravel site.

pits or trenches on 2.8 ha (7 ac) of land. The largest pit is 45 m (150 ft) by 15 m (50 ft) and the deepest pit is about 2.4 m (8 ft) deep. A sketch of the site and pit locations are shown in Figures 7-2 and 7-3. The pits are identified as Nos. 1 through 12. The respective dimensions, volumes, and uses of each pit are presented in Table 7-1.

The climate of Rhode Island is characterized by moderately heavy precipitation, high evaporation, and a wide range of temperature. In general, the winters are cold, having extreme temperatures of short duration, and the summers are cool but humid. Based on 30 years of record, the average annual temperature in the area is 15°C (59°F) and the average annual precipitation is 108.6 cm (42.75 in.). There are an average of 123 days between October and April with minimum temperatures of 0°C (32°F) or less.

The site lies in a hilly northwestern upland of Rhode Island, a continuation of the New England Upland of eastern Connecticut and southeastern Worchester County in Massachusetts. The ground surface of the waste disposal site slopes gently to the northwest. Immediately to the west, the ground surface drops steeply to Tarklin Brook which ultimately enters Slatersville Reservoir. The Slatersville Reservoir, approximately 300 m (1,000 ft) north of the site, currently supplies the City of Woonsocket with 13.2 m^3/sec (58.3 gal/sec) of water. The reservoirs are popular recreational areas and were originally constructed for supply water for power generation, processing, and waste disposal for textile mills. There are also a number of lakes, ponds, and swamps in the area. The land is mostly wooded and has some open pastures for grazing. The general topography of the site has been radically altered from its natural state by the sand and gravel mining operations.

Although the ground water in the general area is relatively undeveloped, the WS&G site is located above the major aquifer and principal recharge area of the Slatersville Reservoir. [7-1]. The quality of this aquifer is such that little treatment is required for its use as a municipal water supply. The aquifer consists of layers of sorted gravel, sand, silt, and clay drift that were deposited in valleys from glacial meltwater. Ground water flow beneath the site is to the north in the direction of the Slatersville Reservoir with velocities on the order of 0.3 to 0.9 m (1 to 3 ft) per day.

Till and bedrock aquifers, hydraulically interconnected with the stratified drift aquifer, have much lower ground water yields. The till is a poorly sorted, non-stratified, dominantly sandy deposit composed of varying proportions of clay, silt, sand, gravel, and boulders. The till covers the bedrock surface in uplands and lies beneath the stratified drift at most places

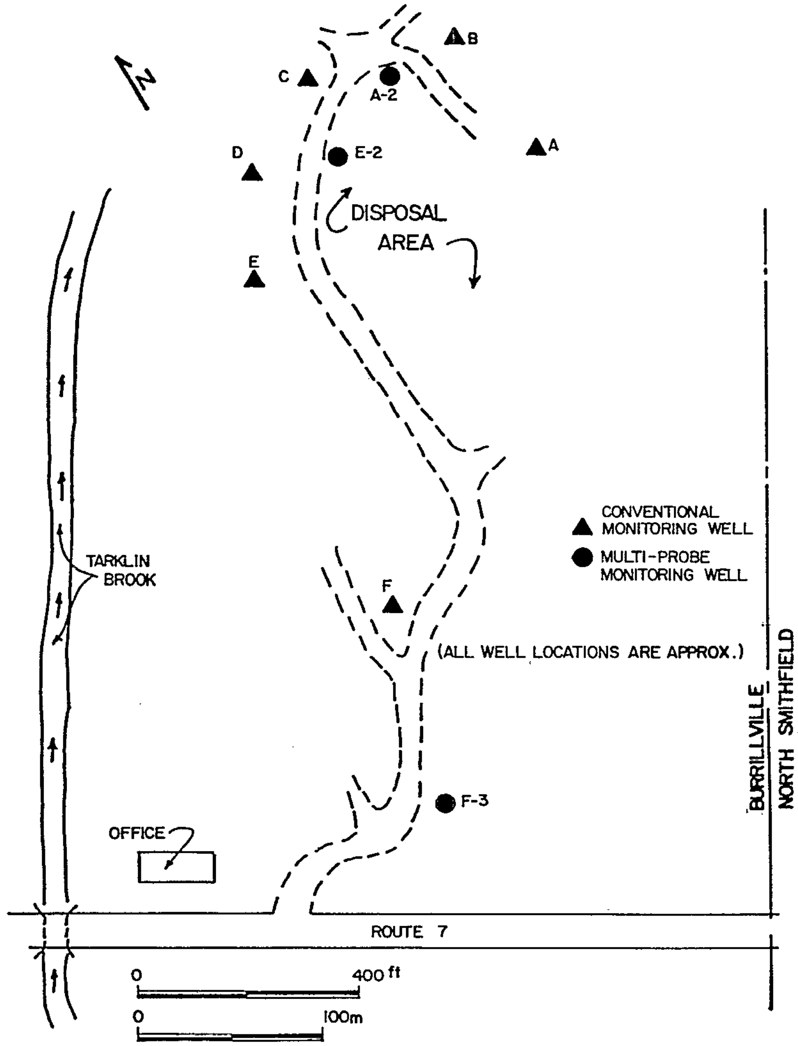


Figure 7-2. Site environs and monitoring well locations.

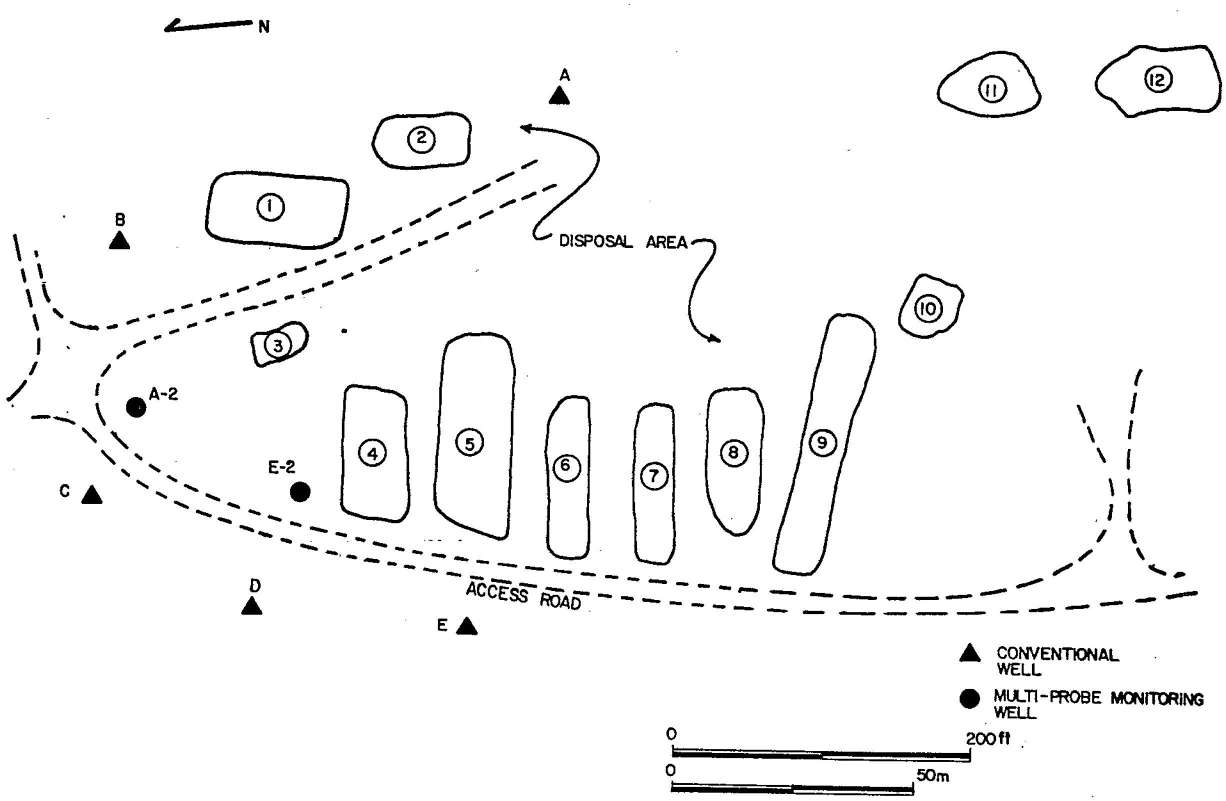


Figure 7-3. Well and pit location map.

TABLE 7-1. PIT DIMENSIONS AND VOLUMES

Pit No.	Depth (m)	Width (m)	Diameter (m)	Depth (m)	Volume (m^3)	Pit Use
1	27.4	9.1	--	1.8	450	Septage
2	5.2	3.7	--	1.5	29	Oil and chemicals
3	3.4	1.5	--	0.6	3	Chemicals
4	27.4	9.1	--	1.8	450	Chemicals
5	45.7	15.2	--	1.8	1,250	Septage
6	18.2	4.6	--	1.8	150	Septage
7	18.2	4.6	--	1.8	150	Septage
8	18.2	4.6	--	1.8	150	Septage
9	30.5	6.1	--	1.8	335	Septage
10	9.1	4.6	--	1.8	75	Septage
11	18.2	4.6	--	1.8	150	Oil and chemicals
12	--	--	30.5	1.8	1,315	Septage
Subtotal - Oil and chemicals					632	
Subtotal - Septage					3,875	
Total - All Uses					4,507	

1 m = 3.28 ft
1 m^3 = 264 gal

in the lowlands. The bedrock aquifer consists of igneous and metamorphic bedrock (granite beneath the site) and water occurs almost exclusively in a network of irregularly spaced fractures. Subsurface flow from bedrock to stratified drift is a source of recharge to the stratified aquifer. Three well logs from the site are presented in Appendix 7-1.

SITE OPERATION AND HISTORY

During the period of active dumping from 1975 to 1979, large amounts of hazardous and septic wastes were dumped at the site. Records of the types of chemicals and the dates and locations of the discharges are not available because the operator failed to keep complete detailed records listing such information. Known wastes dumped include septage, oils, acid and alkaline cleaning agents, heavy metals, cutting coolants, paint residues, perchloroethylene, and aromatic and halogenated solvents. Most of the wastes consist of several phases of liquid, suspended solids, settleable solids, and sludges and slurries.

An estimated total of 1,586 m^3 (419,000 gal) of septage has been dumped into the pits over the operational life of the site. In addition, up to 125 m^3 (33,000 gal) of hazardous wastes were disposed monthly, representing about 14 percent of the hazardous wastes land disposed in Rhode Island at the time. About 80 percent of the wastes disposed into the pits were believed to be aqueous acid or alkaline waste. About 10 percent were a mixture of oil, solvent, and acid and alkaline cleaning agents. The remaining was predominantly catch basin cleanout generated by various companies. The estimated volumes of sludge material contained in the pits is presented in Table 7-1.

In July 1975 WS&G asked and received permission from the Rhode Island Department of Health (RIDOH) to dispose of septage into two pits. In late 1976 and early 1977 chemicals were dumped into the pits without approval from RIDOH. The ensuing citizen concern over the health and safety of the dump site resulted in numerous complaints. In the spring of 1977, a substantial number of complaints were made to RIDOH because of the severe off-site odors originating from WS&G. WS&G was notified by the Town of Burrillville and the North Smithfield Fire Department to remove the chemicals. Several days later the chemicals were buried.

Inspection of the site by RIDOH revealed WS&G to be in violation of the guidelines for facilities receiving septic tank and cesspool pumpings. Specifically, pit length was found to exceed 15.2 m (50 ft) and the depth exceeded 2.1 m (7 ft). There were no stakes or signs on the finished trenches and there was no fencing around the pits. Finally, five pits were found to exist exceeding the two pit limit established in 1975. The site was ordered closed by the RIDOH.

At a hearing on May 2, 1977, the site was ordered to remain closed. This order was stayed by the Superior Court on May 5, 1977 and the guidelines used to regulate disposal facilities were declared null and void, allowing WS&G to continue their waste disposal practices. New laws and regulations governing the disposal of septic waste were drafted in July 1977. In the spring of 1978, "The Rhode Island Hazardous Waste Management Act" was passed by the Rhode Island legislature. The law created procedures for communities to sue for better enforcement of existing regulations, to challenge regulations if considered inadequate, and even to stop environmentally harmful actions not covered by the regulations.

On November 30, 1978, the Towns of North Smithfield and Burrillville, acting jointly, petitioned the Attorney General's office to initiate legal action against WS&G as a hazard to public health. On February 2, 1979, the special assistant to the Attorney General stated that the evidence did not justify closure of the site and would not support the initiation of legal action against WS&G under any statutory or common-law principle. However, legal action was considered if evidence of pollution should develop in the future.

Inspection of the disposal site in the spring of 1979 revealed violation of the "Hazardous Waste Disposal Facility Rules and Regulations", which became effective December 21, 1978. WS&G was found in non-compliance for not preparing complete and accurate manifests which describe the chemical make-up of wastes disposed at the site. Also, inspections were made since residents living near WS&G complained of noxious odors from the dump. State inspectors confirmed the complaints by determining that objectionable odors could be detected beyond the facility's property line in clear violcation of the new State regulations.

On April 24, 1979 the RIDOH issued an order directing WS&G to immediately cease accepting or disposing of any hazardous wastes. The order also required WS&G to prepare and submit plans to the RIDOH no later than May 7, 1979 for permanent closure of their disposal facility. In accordance with the RIDOH order, the permanent closure had to take place no later than June 1, 1979.

POLLUTION

For several years residents living near the disposal site and local officials have been concerned that toxic and hazardous wastes dumped at the WS&G would pollute surface and ground water supplies.in the area. Water samples taken in December 1978 from a stream bordering the WS&G site revealed no bacterial or chemical pollution. Water samples taken from drinking water wells located in the vicinity of WS&G also showed no trace of pollution attributable to the dumping site.

In a June 1979 meeting, RIDOH officials approved the installation of six monitoring wells. This was part of a consent order for the permanent closure of the facility. The six monitoring wells were installed in November 1979 throughout the disposal area and all were perforated through the entire depth of the water table. Well B was installed to drill auger refusal; the remaining were installed to refusal or 21 m (70 ft). Wells D and E were located in the Tarklin Brook flood plain adjacent to the disposal site (see Figures 7-2 and 7-3).

Information obtained from the monitoring wells, residential wells, and Tarklin Brook indicated the presence of a contamination plume which was stratified with depth. Contaminants appeared to be concentrated at the top and bottom of the stratified drift aquifer. Visual observation and studies of the quality of water in Tarklin Brook showed that it was intercepting a portion of the plume. Leachate seeps in Tarklin Brook were noted. However, the monitoring wells could not fully determine the location or extent of the plume.

Because the six monitoring wells failed to clearly answer questions regarding the ultimate destination of contaminants, additional monitoring wells were required. Ground water sampling wells each with probes at multiple levels were chosen to provide ground water quality information with depth and to ultimately assess the conditions of the aquifer in the vicinity of the disposal site. In February 1980, a consulting firm under contract to RIDOH installed these multi-probe wells. The installation details for each sampling location are presented in Appendix 7-1. A summary of the field permeability tests is included in Table 7-2.

On February 26, 1980 representatives of the Division of Water Resources and the consultant met for the purpose of sampling and measuring the various disposal pits located at WS&G. The EPA conducted a sampling program of their own at the same time. The primary purpose of the sampling was to obtain sludge and sediment samples for PCB analysis, and to obtain samples from the chemical pits for complete organic analyses. The results of the pit sampling are provided in Table 7-3.

Samples from the multi-probe wells, conventional wells, private wells, and surface water were taken on February 6 and 7 and again on May 1, 1980 through State, federal, and private testing. Severe ground water contamination has been detected on the site and points downstream from the disposal area, some as far as 305 m (1,000 ft) downstream where Tarklin Brook enters the Slatersville Reservoir. Chemical contaminants have also been found in five private wells in the vicinity of WS&G. Results of the testing are presented in Tables 7-4 and 7-5.

TABLE 7-2. SUMMARY OF FIELD PERMEABILITY TESTING RESULTS

Exploration Number	Depth (m)	K-Range[1] (cm/sec x 10^{-3})	Average K[1] (cm/sec)	Test Type	Soil Strata Description
A-2	11.2	2.3 - 2.6	2.5×10^{-3}	Flush Bottom	Stratified Sand
A-2	11.2	0.7 - 0.8*	8.1×10^{-4}	Wick Test	Stratified Sand
A-2	19.2	1.0 - 1.1	1.1×10^{-3}	Flush Bottom	Stratified Sand
A-2	29.1	1.5 - 2.0	1.7×10^{-3}	Flush Bottom	Stratified Sand
A-2	33.2	4.3 - 8.0*	6×10^{-3}	Wick Test[2]	Stratified Sand
A-2	49	0.4 - 0.5	4.4×10^{-4}	Flush Bottom	Silty Sand
E-2	19	0.35 - 0.37	3.7×10^{-4}	Flush Bottom	Fine to Medium Sand
E-2	49	0.41 - 0.43	4.2×10^{-4}	Flush Bottom	Stratified Sand
F-2	25-27	---	3.0×10^{-5}*	Wick Test	Glacial Till
LFRR-A	14.3	0.4	4.0×10^{-4}	Flush Bottom	Silt
LFRR-A	39.2	0.15 - 0.24	2.0×10^{-4}	Flush Bottom	Silt
LFRR-B	14.1	0.10 - 0.14	1.2×10^{-4}	Flush Bottom	Silty Sand
LFRR-B	39.1	0.5 - 0.8	7.0×10^{-4}	Flush Bottom	Silty Sand
LFRR-B	54.1	1.3 - 1.9	1.6×10^{-3}	Flush Bottom	Fine to Coarse Sand

NOTES:

1. K represents average mean coefficient of permeability for flush bottom tests and average horizontal permeability for wick tests (denoted *).
2. Constant head test. (All others falling head.)
3. Calculations based on equations from Hvorslev (1949).

1 cm = 0.4 in.
1 m = 3.28 ft

TABLE 7-3. ANALYTICAL RESULTS FOR PIT SAMPLING ON 2/27/80

Parameter	Pit 1	Pit 2			Pit 3		Pit 4		
	Sludge	Top	Liquid	Sludge	Top	Sludge	Liquid*	Liquid***	Sludge
Arsenic (mg/kg)	0.8	0.5	--	0.6	0.4	0.7	--	--	0.6
Lead (mg/kg)	7.0	32.0	--	8.0	38.0	47.0	--	--	82.0
Mercury (mg/kg)	<0.3	<0.3	--	<0.5	0.5	0.6	--	--	<0.3
Toluene (ppb)	--	20,000	360	--	31,000	--	270,000	6,300	--
Xylene (ppb)	--	390,000	630	--	410,000	--	1,400,000	9,700	--
Tetrachloroethylene (ppb)	--	2,900	2	--	250,000	--	210,000	19,000	--
Trichloroethylene (ppb)	--	1,600	5	--	220,000	--	72,000	25,000	--
1,1,1-Trichloroethane (ppb)	--	6,800	--	--	300,000	--	56,000	21,000	--
Methylene Chloride (ppb)	--	2,800	--	--	--	--	75,000	66,000	--
Chloroform (ppb)	--	--	--	--	--	--	5,600	--	--
PCB (ppm)	<50.0	--	--	--	--	--	--	--	--

Parameter	Pit 5	Pit 6	Pit 7	Pit 8	Pit 9	Pit 10	Pit 11		
	Sludge	Sludge	Sludge	Sludge	Sludge	Sludge	Top	Liquid	Sludge
Arsenic (mg/kg)	<0.2	0.3	0.5	0.3	8.0	0.4	0.5	--	2.0
Lead (mg/kg)	20.0	98.0	38.0	58.0	538.0	42.0	26.0	--	32.0
Mercury (mg/kg)	0.4	1.0	<0.5	<0.5	0.3	<0.5	<0.5	--	<0.2
Toluene (ppb)	--	--	--	--	--	--	23,000	680	--
Xylene (ppb)	--	--	--	--	--	--	120,000	730	--
Tetrachloroethylene (ppb)	--	--	--	--	--	--	420,000	3	--
Trichloroethylene (ppb)	--	--	--	--	--	--	--	--	--
1,1,1-Trichloroethane (ppb)	--	--	--	--	--	--	7,100	650	--
Methylene Chloride (ppb)	--	--	--	--	--	--	1,200	510	--
Chloroform (ppb)	--	--	--	--	--	--	--	--	--
PCB (ppm)	<50	<50	<50	<50	<50	<50	--	--	--

TABLE 7-4. ANALYTICAL RESULTS FOR WELL AND STREAM SAMPLING ON 2/7/80

Parameter	Well Location								
	F3-1	F3-2	E2-1	E2-2	E2-3	E2-4	A2-1	A2-2	A2-3
Benzene (ug/l)	<200	<20	11,077	<20	2,091	3,098	<20	<20	<20
Toluene (ug/l)	164	<20	21,560	66	6,070	12,314	<20	<20	<20
Xylene (ug/l)	533	<20	18,880	28	9,710	16,152	<20	<20	<20
Carbon Tetrachloride (ug/l)	<1	<1	<1	<1	<1	<1	<1	<1	<1
Trichloroethylene (ug/l)	12	<1	2,033	4	1,176	1,343	<1	<1	<1
1,1,1-Trichloroethane (ug/l)	56	<1	<1	18	2,525	2,678	<1	<1	<1
Bromodichloromethane (ug/l)	<1	<1	<1	<1	<1	<1	<1	<1	<1
Chloroform (ug/l)	7	<1	9,020	14	1,085	779	<1	<1	<1
Dibromochloromethane (ug/l)	<1	<1	<1	<1	<1	<1	<1	<1	<1
PCB (ug/l)	--	<1	<20	<1	<20	<40	<1	<1	<20
Tetrachloroethene (ug/l)	2	<1	368	5	280	222	<1	<1	<1
Arsenic (mg/l)	--	<0.005	0.115	<0.005	0.062	0.32	0.031	<0.005	0.012
Barium (mg/l)	--	<0.033	1.12	0.21	0.70	0.60	0.31	0.032	0.20
Cadmium (mg/l)	--	<0.002	0.13	<0.002	0.09	0.10	0.004	<0.002	0.005
Chromium (mg/l)	--	<0.02	0.26	<0.02	0.23	1.2	0.06	<0.02	0.05
Copper (mg/l)	--	<0.02	110	<0.02	20.5	92.0	0.33	0.06	0.31
Lead (mg/l)	--	<0.005	0.12	<0.005	0.021	0.10	0.46	0.11	0.13
Mercury (mg/l)	--	<0.0018	0.0018	<0.001	0.0012	0.0022	0.0012	<0.001	0.0012
Nickel (mg/l)	--	<0.02	3.9	<0.02	3.7	4.0	0.17	0.02	0.16
Selenium (mg/l)	--	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
Silver (mg/l)	--	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.02
Zinc (mg/l)	--	0.11	120	<0.02	60	128	3.0	0.11	5.0

Parameter	Stream Location		
	S1	S2	S3
1,1,1 Trichloroethane (ppb)	<1	1	18
Benzene (ppb)	<20	<20	<20
Toluene (ppb)	<20	<20	<20
Xylene (ppb)	<20	<20	<20
Chloroform (ppb)	<1	<1	<1
Carbon Tetrachloride (ppb)	<1	<1	<1
Trichloroethylene (ppb)	<1	<1	3
Tetrachloroethylene (ppb)	<1	<1	<1
Bromodichloromethane (ppb)	<1	<1	<1
Dibromochloromethane (ppb)	<1	<1	<1
Turbidity	0.5	1.2	9.3
Dissolved Oxygen	12.7	12.5	2.8
BOD	1	1	1
pH	7.0	6.2	6.0
Ammonia	0.04	0.04	0.06
Alkalinity	4	5	11
Chloride	6	9	22
Suspended Solids	0	5	2

TABLE 7-5. ANALYTICAL RESULTS FOR WELL SAMPLING ON 5/1/80

Parameter	Well Location								
	F3-1	F3-2	A2-1	A2-2	A2-3	E2-1	E2-2	E2-3	E2-4
Benzene (ppb)	<20	<20	<20	<20	<20	6,000	5,500	2,300	1,100
Xylene (ppb)	<10	<10	<10	<10	<10	8,400	8,500	5,800	3,000
Toluene (ppb)	<10	<10	<10	<10	<10	10,600	10,200	4,800	2,300
Chloroform (ppb)	<1	<1	<1	<1	<1	9,900	9,100	7,900	<1
Bromodichloromethane (ppb)	<1	<1	<1	<1	<1	<1	<1	<1	<1
Bromoform (ppb)	<1	<1	<1	<1	<1	8	8	5	5
Dibromochloromethane (ppb)	<1	<1	<1	<1	<1	<1	<1	<1	<1
Trichloroethylene (ppb)	<1	<1	<1	<1	<1	620	750	1,600	2,300
Carbon Tetrachloride (ppb)	<1	<1	<1	<1	<1	<1	<1	<1	<1
Tetrachloroethylene (ppb)	<1	<1	<1	<1	<1	320	160	190	150
1,1,1-Trichloroethane (ppb)	<1	<1	<1	<1	<1	<1	<1	<1	1,900
PCB (ppb)	<10	<5	<5	<5	<5	<5	<5	<5	<5
Arsenic (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005	0.03	0.027	0.008	0.0
Barium (mg/l)	0.15	0.039	0.075	<0.01	0.24	0.28	0.62	0.23	0.15
Cadmium (mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	0.88	0.07	0.05	0.05
Chromium (mg/l)	0.03	<0.02	<0.02	<0.02	0.02	0.2	0.2	0.07	1.0
Copper (mg/l)	0.21	0.06	0.19	0.05	0.09	38.0	75.0	12.0	44.0
Lead (mg/l)	0.22	<0.005	0.2	<0.005	0.06	0.89	0.044	<0.005	0.13
Mercury (mg/l)	0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.002	0.002
Nickel (mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	3.3	2.6	2.1	1.9
Selenium (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silver (mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Zinc (mg/l)	0.95	<0.02	1.05	0.065	0.115	140.0	82.0	25.0	71.0

REMEDIAL ACTION

Because of the immediate health threat to citizens living in the surrounding area, RIDOH has been under pressure to clean-up the site. RIDOH issued an order against WS&G in December 1979 requiring WS&G to remove all waste materials contained in the pits within a specified timeframe. WS&G did not comply with this order. As a result, RIDOH obtained legal authorization to undertake closure of the site.

Because wastes continued to seep into the subsurface from the pits, the EPA assumed jurisdiction under the 311 provisions of the Clean Water Act in February 1980 and ordered the removal of the contents from four pits containing hazardous wastes. Work began on March 4, 1980 and 144 m^3 (38,000 gal) of liquid were pumped and transported to Stoughton, Massachusetts for storage. In addition, 296-0.2m^3 (55 gal) drums of sludge were removed from the pits and are now stored at the site. An additional amount of sludge and contaminated sand has been mixed with sawdust and covered with polyethylene and stored at the east end of the pits.

On February 20, 1980, RIDOH was given authority to hire a private firm for the removal and disposal of the liquid and sludge septic wastes not removed under 311 work. Three alternatives were proposed: (1) sludge waste removal for on-site storage; (2) sludge waste removal for off-site disposal, and (3) sludge waste disposal on-site. An agreement has been reached with the Blackstone Valley District Commission for the disposal of the liquid septage at their facility in Lincoln, Massachusetts. An estimated 317 m^3 (415 yd^3) of septage will be removed at the direction and expense of RIDOH.

An interim hydrogeologic report prepared by a consultant in June 1980 concluded that "the major water quality threat is to private wells down-gradient of the disposal site, primarily in an area to the west of Tarkiln Brook and south of the Slatersville Reservoir. Therefore, if a do nothing policy is adopted, a permanent alternate water supply will have to be provided for homes served by domestic wells located in the plume." [7-1]

The cost to the State of Rhode Island for the removal of wastes at WS&G is estimated to be over $1,000,000. The pumping of the septage and chemical wastes and its removal and disposal is estimated to be $483,724. If a leachate collection and treatment system is installed it will cost approximately $362,000. Contingencies could cost another $250,000. The breakdown of total estimated costs is given in Table 7-6.

CONCLUSION

Considering the poor records and disposal methods encountered at this site, the identification of the precise limits of

TABLE 7-6. ESTIMATED REMEDIAL ACTION COSTS

Pumping out septage pits (963,000 gal @ $0.04/gal)	$ 38,520
Tipping charge (@ $8.00/1,000 gal)	7,704
Pumping out chemical pits (250,000 gal @ $1.25/gal)	312,500
Sludge removal and disposal (100,000 gal @ $1.25/gal)	125,000
Well points	12,000
Leachate collection and treatment (2 years)	270,000
Site preparation	30,000
Impermeable membrane	40,000
Subtotal	$ 835,724
Contingencies (@ 30 percent)	250,717
Total	$1,086,441

contaminated ground and surface water has been a costly undertaking. Since the mere identification of the problem was not considered a solution, RIDOH proposed to establish a means of dealing with the situation before it had an opportunity to spread to adjacent land and water supplies.

The remedial action taken by EPA under 311 funds to remove the hazardous wastes and the proposed work under the authority of RIDOH to remove septic wastes is a starting point for the complete clean-up of the site. However, remedial action should have been initiated long before the 311 work. WS&G is hydrogeologically a poor location for a hazardous waste site. WS&G should never have been permited to accept waste and immediate action should have been taken when it first became evident in 1976 that WS&G was causing problems.

Of the remedial actions available to abate or control the contamination plume, the leachate collection and treatment system appears to be the most cost-effective. A well point dewatering system could be implemented. Since the contamination plume has migrated beyond the boundaries of WS&G, it would be necessary to install a number of wells further down-gradient from the main cluster of wells.

If remedial actions are not initiated, the ground water and the Slatersville Reservoir will likely become extensively contaminated. Alternate water supplies, including new reservoirs and a public water supply system to local residents, would be needed in the near future. In addition, it will jeopardize the economic, industrial, and domestic development of the region as well as endangering the health, safety, and welfare of the citizens. These costs far outweigh the costs of cleanup.

SITE F REFERENCES AND BIBLIOGRAPHY

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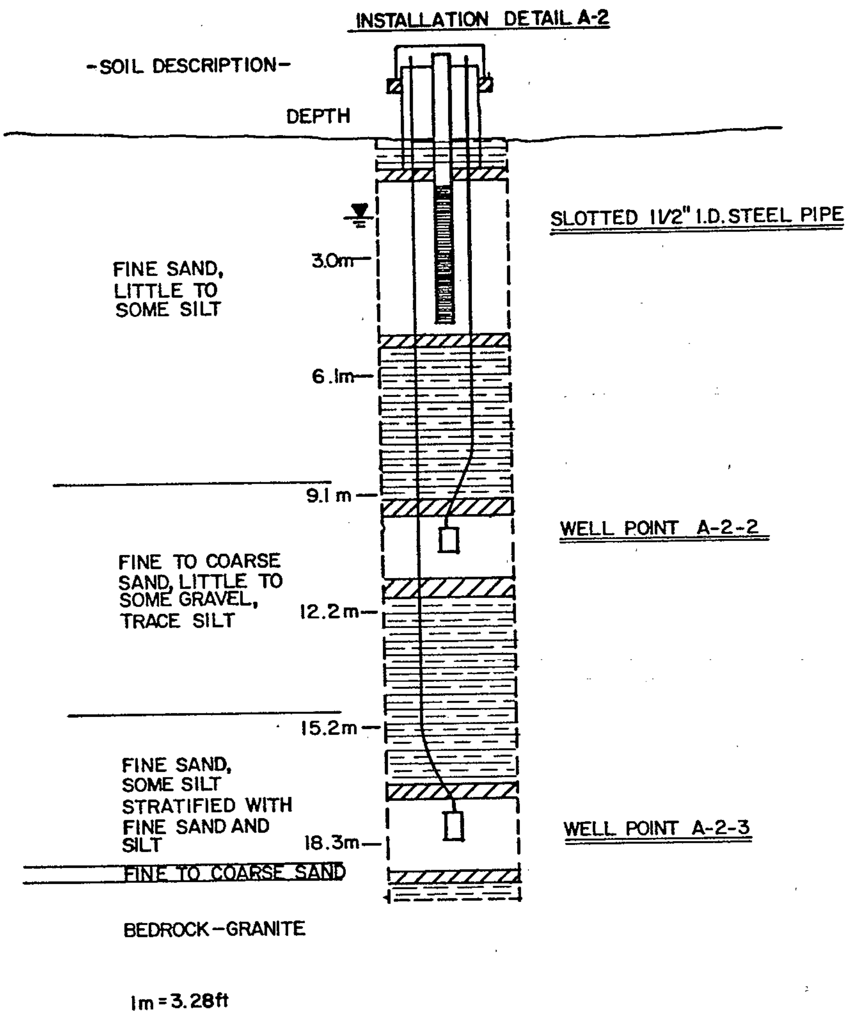
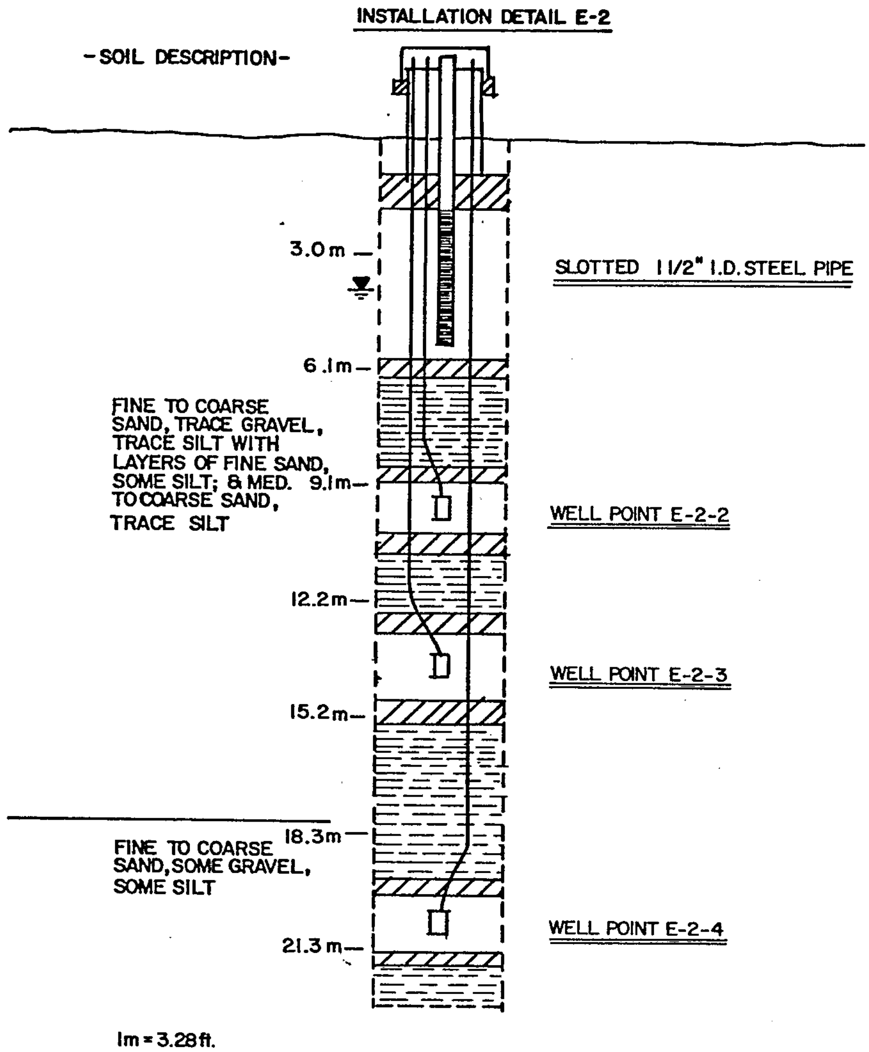
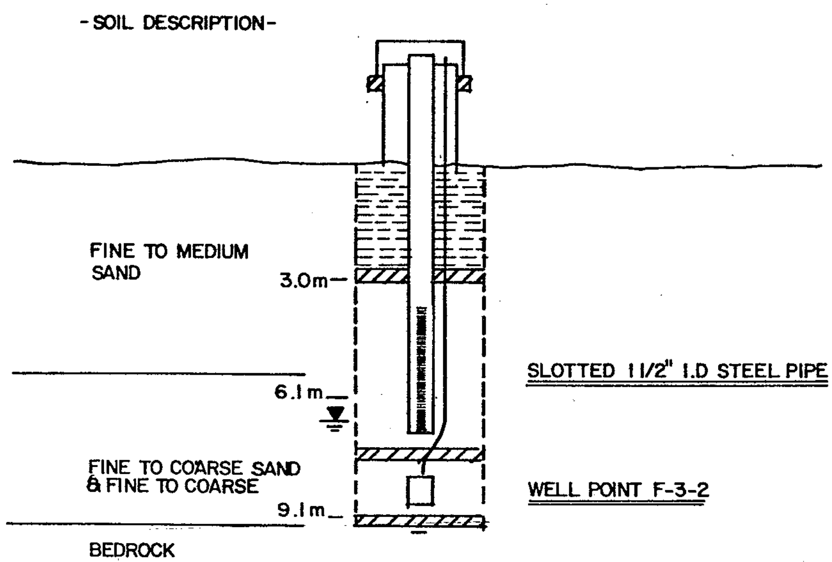
APPENDIX 7-1

MULTI-PROBE WELL INSTALLATION DETAILS
FOR SITE F


INSTALLATION DETAIL A-2
-SOIL DESCRIPTION-
DEPTH
SLOTTED 11/2" I.D. STEEL PIPE
3.0m
FINE SAND, LITTLE TO SOME SILT
6.1m
9.1 m
WELL POINT A-2-2
FINE TO COARSE SAND, LITTLE TO SOME GRAVEL, TRACE SILT
12.2m
15.2m
FINE SAND, SOME SILT STRATIFIED WITH FINE SAND AND SILT
18.3m
WELL POINT A-2-3
FINE TO COARSE SAND
BEDROCK-GRANITE
1m = 3.28ft


INSTALLATION DETAIL E-2
-SOIL DESCRIPTION-
3.0 m
6.1 m
FINE TO COARSE SAND, TRACE GRAVEL, TRACE SILT WITH LAYERS OF FINE SAND, SOME SILT; & MED. TO COARSE SAND, TRACE SILT
9.1 m
12.2 m
15.2 m
18.3 m
FINE TO COARSE SAND, SOME GRAVEL, SOME SILT
21.3 m
SLOTTED 1 1/2" I.D. STEEL PIPE
WELL POINT E-2-2
WELL POINT E-2-3
WELL POINT E-2-4
1m = 3.28 ft.

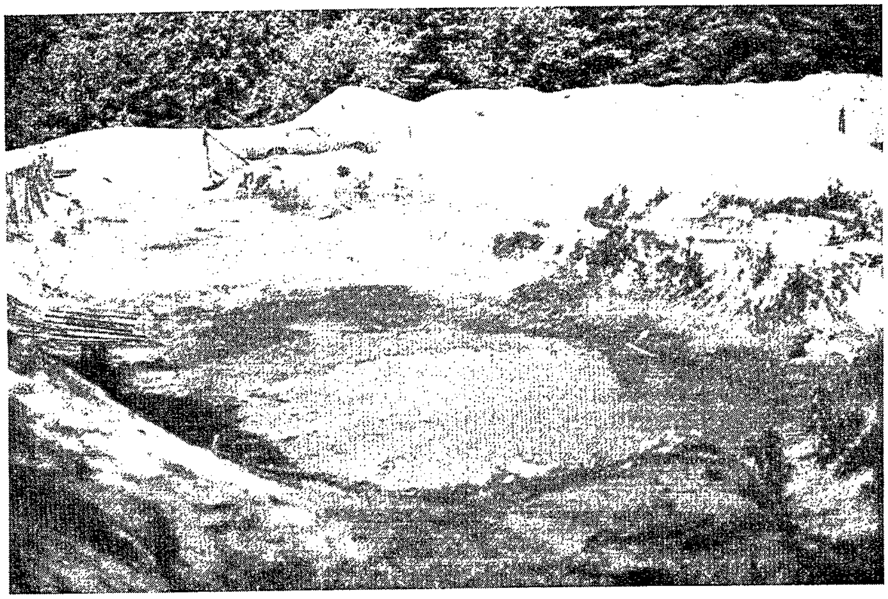
INSTALLATION DETAIL F-3

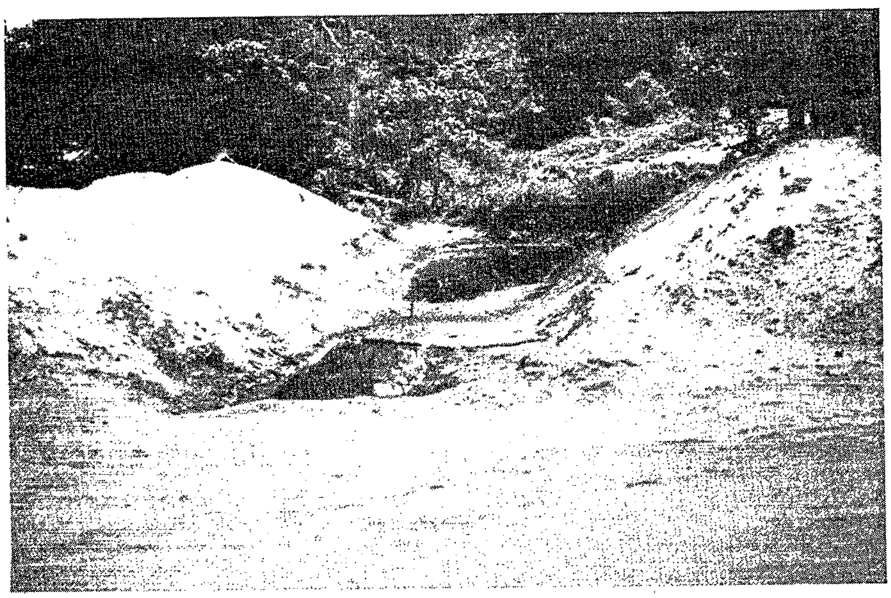


1m = 3.28 ft

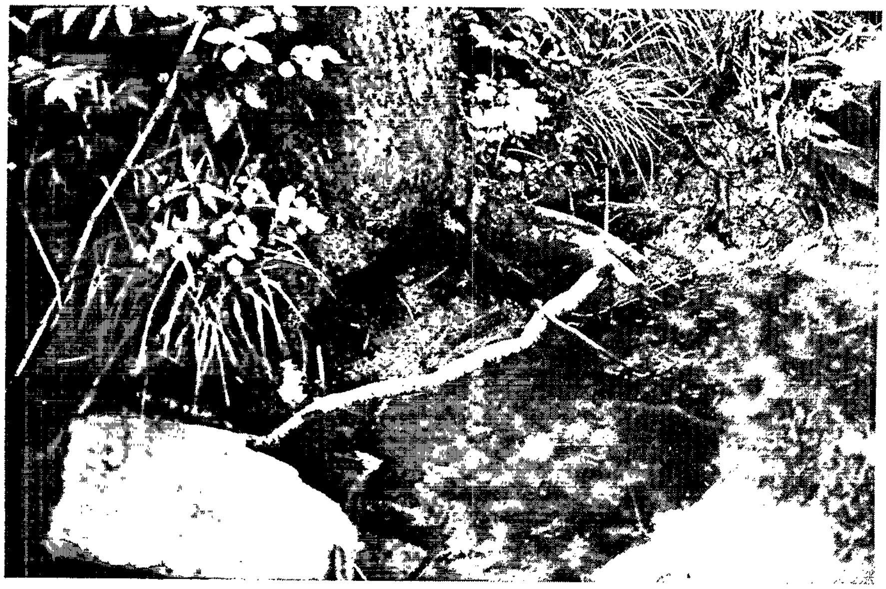
APPENDIX 7-2

SITE F PHOTOGRAPHS

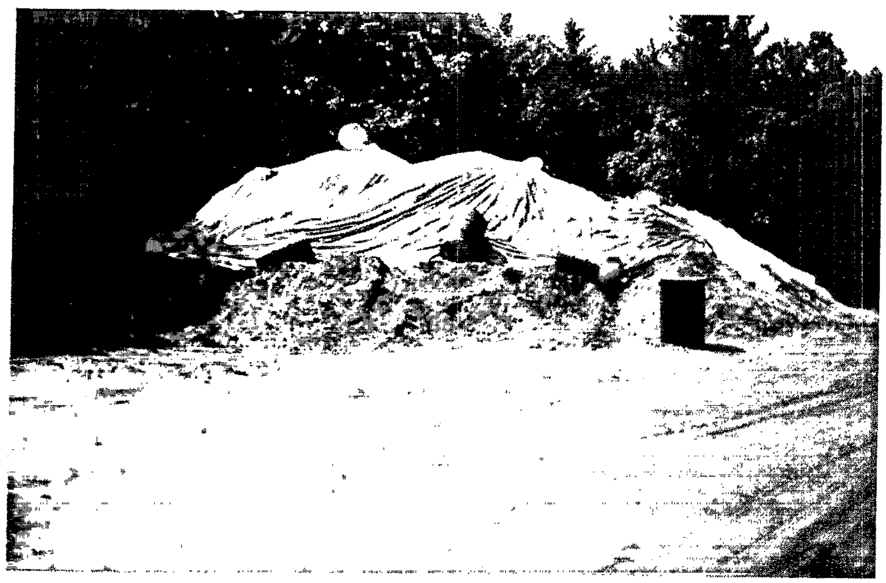




Two waste disposal pits at Western Sand and Gravel. Note the excavated sand characteristic of the disposal site.



Location of leachate seep into Tarklin Brook emanating from the disposal pits.



View of the sludge contaminated sand and sawdust mixture stored at Western Sand and Gravel. Note the polyethylene cover.

Collecting samples from multi-probe well used to provide ground water quality data at Western Sand and Gravel site.

SECTION 8

SITE G
FERGUSON PROPERTY
ROCK HILL, SOUTH CAROLINA

INTRODUCTION

Approximately 2 ha (5 ac) of land in north-central South Carolina was leased from the Ferguson Family by Industrial Chemical Company, Inc. (ICC) in the mid-1960's. The land was used to store solvents prior to their reclamation. In 1966 ICC vacated the site, leaving behind approximately 2,500 to 5,000 drums of waste. Subsequently, the situation came to the attention of the South Carolina Department of Health and Environmental Control (SCDHEC) in 1976. A site investigation found many of the drums to be corroded and leaking. Sample analyses of the drummed material revealed highly flammable and toxic material. It was suspected that some of the leakage had seeped into a nearby stream.

SCHDEC attempted to persuade ICC and the landowner to come to a mutual agreeement for cleaning up the site. Since neither party would accept responsibility and since the site represented a fire and pollution hazard, the U.S. Environmental Protection Agency (EPA) Region IV, Environmental Emergency Branch (EEB) initiated cleanup activities. After their first containment attempt was ineffective, EEB returned to remove drummed wastes and contaminated rainwater. The contaminated rainwater was removed and hauled to a wastewater treatment plant for processing. A substantial amount of the drummed waste was removed from the site and reclaimed, with deteriorated drums and some contaminated soil buried on-site.

Currently some liquids and sludges in drums and tanks remain at the site, even after the second remedial activity described above. It is expected that some additional actions will be necessary to remove the long term threat to the environment. To this end, the SCDHEC is pursuing legal action to assign responsibility for future cleanup costs.

SITE DESCRIPTION

As shown in Figure 8-1, the site is located in north-central South Carolina about 3 km (2 mi) west of the City of Rock Hill. The site occupies 1.2 to 2.0 ha (3 to 5 ac) of 42.3 ha (104.5 ac) owned by the Ferguson Family. The site is bordered by a tributary to Fishing Creek, which is a tributary to the Catawba River.

The area's normal precipitation is approximately 107 cm/year (42 in./year); average snowfall is approximately 13 cm/year (5 in./

year). The annual average wind speed is 12 kph (7.5 mph). The average daily high temperature is 16°C (61°F), with the highest daily maximum in July at 31.3°C (88.3°F) and lowest in January at 0.1°C (32.1°F).

The topography of the area is characteristically rolling hills. The slope range is 0 to 30 percent and the total relief is about 15 m (50 ft). Vegetation is extensive, covering nearly all of the land. The site itself was covered with tree growth and kudzu (a leguminous vine) prior to implementation of remedial measures.

Deep ancient soils (saprolite) developed in the general area on Precambrian and Paleozoic metamorphic and igneous bedrock. Little site specific information exists about the stratification and depth of soil to bedrock underlying the site. It is known that a minimum 2 m (8 ft) thick layer of red clay soil covers the former drum storage area. The depth to ground water is likewise unknown; however, ground water movement occurs through a network of irregularily spaced fractures. Small springs or diffuse seepage issuing from fault zones or joints are sources of recharge for area streams.

The site is located in the Piedmont Province approximately 24 km (15 mi) west of the Fall Line, a sharply defined boundary marked by a line of rapids and falls separating the slightly elevated rocks of the Piedmont Province from the lower formations of the Atlantic Coastal Plain. The crystalline metamorphic and igneous rocks of the Piedmont Province are grouped in five northeast trending lithologic belts which are interpreted to be zones of different grades of regional metamorphism. Underlying the site is the Charlotte Belt, which is composed of feldspathic gneiss and migmatite of the albite-epidote amphibolite facies. Cross-cutting granite fills fractures. Granite plutons shaped like inverted tear drops occupy folds in localized regions to the east.

SITE OPERATION AND HISTORY

Industrial Chemical Company, Inc. (ICC) operated as a solvent reclaimer, extracting useable solvents from chemical wastes by distillation. During the years 1963 to 1966, ICC leased lands belonging to L.B. Ferguson, Sr. for storing reclaimable industrial waste solvents. In practice, the Ferguson property was used more for drum storage than reclamation. Materials such as paints, inks, and solvents were brought to the site in 0.2 m^3 (55 gal) drums and stored in drums and tanks prior to reclamation.

When the original landowners, Mr. and Mrs. L.B. Ferguson, Sr., died in a car accident, the property ownership was placed in an estate. In 1967, a dispute arose between the heirs to the Ferguson

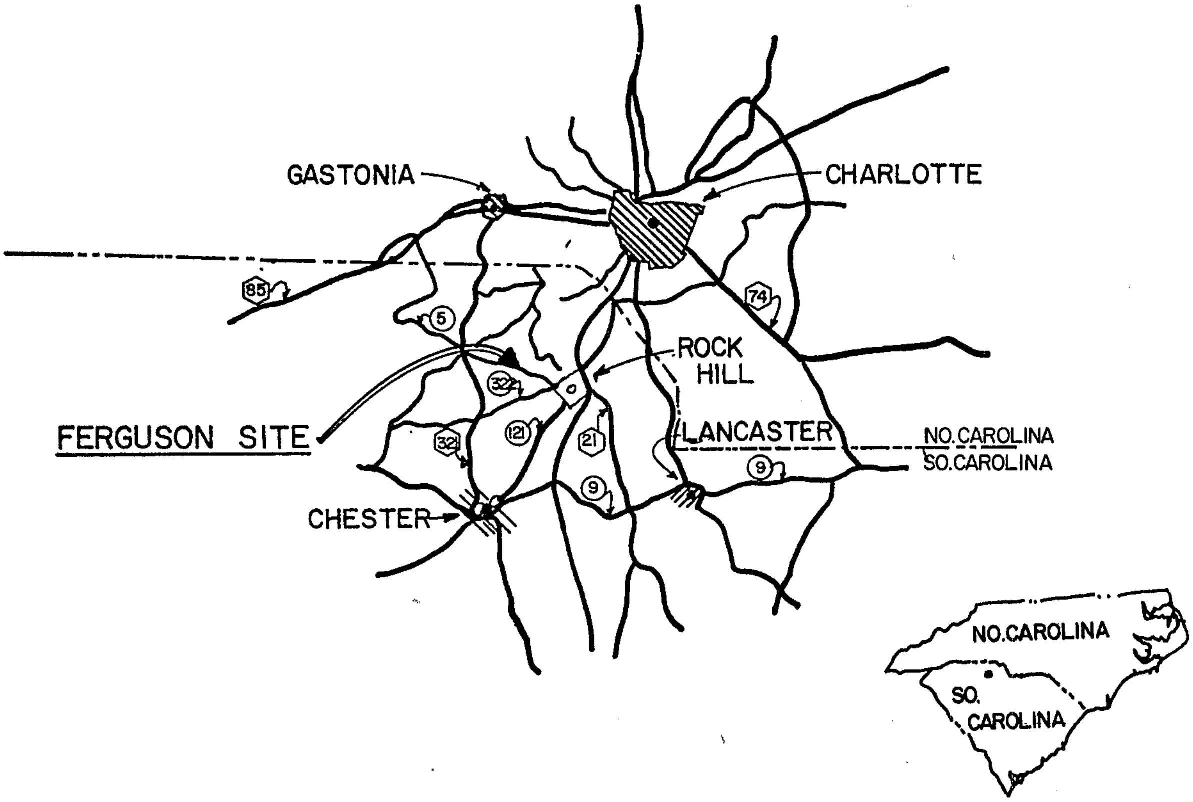


Figure 8-1. Location of Ferguson site in Rock Hill, South Carolina.

estate and ICC regarding the lease. According to W. D. Neal, president of ICC, one of the property heirs demanded immediate payment of rent due. Since ICC was unable to make immediate payment, ICC was informed that neither officers nor employees of ICC were allowed to enter the property for any purpose. [8-1]

ICC vacated the site in 1967 and since that time has had no dealings with the Ferguson heirs. ICC is a small, family-owned corporation. After vacating the property in 1967, ICC purchased property outside of Rock Hill and moved their operations to that site, where it now has a permitted incinerator and landfill.

POLLUTION

For a period of four years, the South Carolina Department of Health and Environmental Control (SCDHEC) tried to persuade the Ferguson heirs and ICC to come to a mutual agreement for removing drums on the Ferguson site. The first SCDHEC site inspection was conducted in March 1978, revealing 2,500 to 5,000 corroded, leaking drums. These drums were unprotected from the elements and placed directly on the ground. Drums were stacked three or more high in many places and were either leaning or fallen over. A large number of drums had also been stacked on the bank of a small stream bordering the site. There were no provisions to prevent leakage of drum contents from entering the stream. Brush growing around the drums indicated that the site had not been maintained for several years.

In October 1978, acting under South Carolina's "Emergency Regulations for Storage of Hazardous Waste", SCDHEC tried to get the two parties to voluntarily resolve the problem at the site, requesting that a mutually agreed-upon plan be submitted to remedy the hazards. Again conferences were scheduled to finalize the agreement between the two parties, but no agreement could be reached. SCDHEC personnel re-inspected the site in July 1979 and collected representative samples for analysis to determine the toxicity of the material. Analyses revealed highly flammable and toxic wastes. The inspection also revealed no change had occurred from the time of the previous inspection and that some discharge into the environment was occurring.

In October 1979, samples were collected from the site by the U.S. EPA Surveillance and Analysis team out of Atlanta, Georgia. Analyses revealed hazardous substances similar to the chemical compounds being incinerated and reclaimed at the new ICC facility. If these were the same wastes, they could be expected to include dirty paint and ink solvents consisting of compounds such as xylene, ethyl chloride, diethyl carbomethoxy phosphate, alcohols, ammonia, and acetic acids. Table 8-1 lists concentrations of primary pollutants found in the drummed waste

TABLE 8-1

1979 U.S. ENVIRONMENTAL PROTECTION AGENCY DRUM AND SOIL ANALYSIS [8-1]

Pollutant	Concentration (mg/kg)	
	Drummed Waste	Soil
Lead	20,430	394
Chromium	3,450	335
Zinc	1,987	1,471
Copper	125	175
Napthalene	82	ND
Dimethyl Phthalate	1,500	ND
Bis (2-ethylhexyl) Phthalate	1,800	1,800
Aroclor 1,254	67	ND
1,1,1-Trichloroethane	26	ND
Benzene	93	ND
Toluene	340,000	9.1
Ethylbenzene	7,400	<5

ND = Not Detected.

and in the soil. Concentrations of priority pollutants in excess of background levels were not detected in the creek. However, the investigation was conducted in dry weather. High concentrations would be more likely in wet weather when rainfall could carry pollutants from the site surface into nearby drainage ways.

Another site inspection was conducted by the SCDHEC and U.S. EPA Region IV Environmental Emergency Branch (EEB) in December 1979. No significant change in site conditions was found. Figure 8-2 displays the location of drums prior to remedial activities. The site is located near residences, a heavily traveled highway, and a stream. If the stacked drums along the stream edge fell and ruptured, the stream could become contaminated. In addition, it was suspected that large quantities of chemicals had discharged into the stream over a period of years from 800 empty drums stacked at the edge of the stream. However, stream samples never indicated detectable contaminants. In addition to potential stream and soil contamination, the drummed chemicals left on the Ferguson property posed a fire hazard.

REMEDIAL ACTION

When it was determined that an agreement between heirs of the Ferguson property and ICC was unlikely to be consummated in a timely manner, EEB initiated a 311 action to eliminate the fire hazard and prevent further contamination of the stream and soil. Temporary containment measures implemented by EEB included removal and relocation of drums and construction of an underground storage area.

During cleanup operations, workers used vinyl suits, plastic splash guards, and carbon canister masks. Oil in a 23 m^3 (6,000 gal) tank was purchased and removed by Alternate Energy Resources of Augusta, Georgia. The empty tank was repositioned and used for storage of liquids withdrawn from deteriorated drums. Chemicals were transferred from rusting leaking barrels to durable containers and relocated away from the stream. The ground above the creek was leveled with bulldozers and intact barrels were arranged in rows and sections. Earthen dikes were constructed around each section of drums. To prevent rainwater infiltration, the sections were covered with a double layer of 0.1 mm (4 mil) polyethylene and thence a 15 cm (6 in.) thick layer of clay to prevent infiltration of rainwater. Pipes were installed through the cover to vent any build-up of pressure inside the mound. A dike and diversion ditch was constructed around the area to divert runoff and the area was seeded. A total of 1,835 drums were moved to the storage area and 800 empty drums were crushed and stored in a containment trench. The complete process took the contractors (O.H. Materials, Inc., of Findlay, Ohio) and the EPA

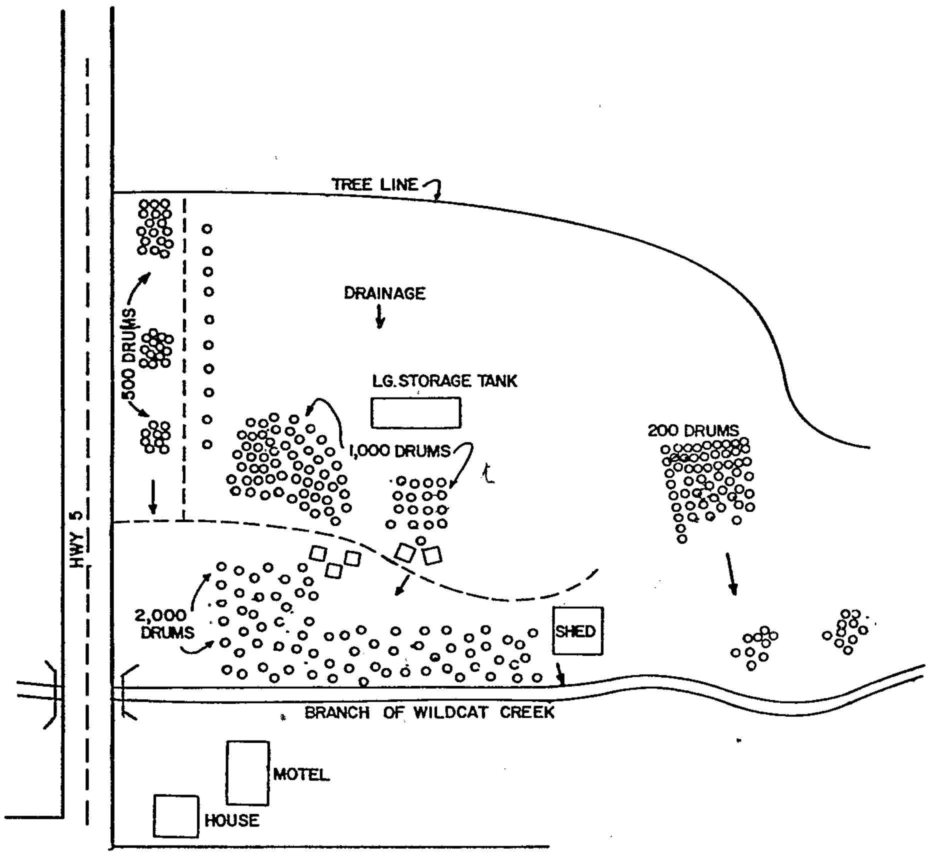


Figure 8-2. Location of drums on Ferguson property. [8-1]

Region IV EEB about a week to complete. This phase of temporary remedial action was completed on January 29, 1980 at a cost of about \$55,000.

In mid-March 1980, approximately six weeks after completion of the above activities, the SCDHEC noticed that the vent pipes installed in the burial mound were discharing liquids resembling contaminated rainwater. It was speculated that the fumes from the waste had decomposed the polyethylene cover allowing overlying soil to cave in. Approximately 20 cave-in areas were noted in the burial mound. It was suspected that rainwater had entered the buried sections containing the drummed waste through these cave-in areas.

Region IV EEB responded promptly to clean up the contaminated rainwater. The water was first pumped from the four disposal sections and collected in the on-site bulk storage tanks. A collection trench was constructed near the creek to prevent spill drainage entering the surface water. The solvents were sampled by M&J Solvents of Atlanta, Georgia to determine the feasibility of reclaiming them. Samples were also taken of the contaminated rainwater and analyzed by an EPA contractor and the SCDHEC. Analyses revealed that the contaminated rainwater could be processed at the Rock Hill Manchester Creek Wastewater Treatment Plant; it was also determined that the solvents could be reclaimed.

Subsequently, the contaminated rainwater was hauled to the treatment plant and 140 m^3 (38,000 gal) of solvents were pumped out of the barrels and trucked to M&J Solvents in Atlanta. The emptied drums were removed from the burial cells to a separate diked area where they were crushed for later disposal. All of the remaining solids, contaminated soil, and empty damaged drums were consolidated, crushed, and buried in saw dust pits. The pits were then covered with top soil and the area was seeded. Approximately 70 drums, which were in good condition, were consolidated and placed at the upper end of the site. Approximately 7.6 to 11 m^3 (2,000 to 3,000 gal) of wet sludge were left at the site in two tanks.

Figure 8-3 displays the pit, barrels, and tank locations at the site after completion of the second set of remedial activities. Approximately two weeks were required for the second temporary remedial activity. The second set of remedial actions cost \$88,000 bringing the total temporary remedial cost to \$143,000. Table 8-2 further defines the cost of the two temporary containment efforts. As was stated before, this action was carried out to minimize potential fire hazards and the possibility of a chemical spill reaching the nearby stream. The permanent/long term remedial action will be forthcoming when a legal determination has been made as to the responsible party.

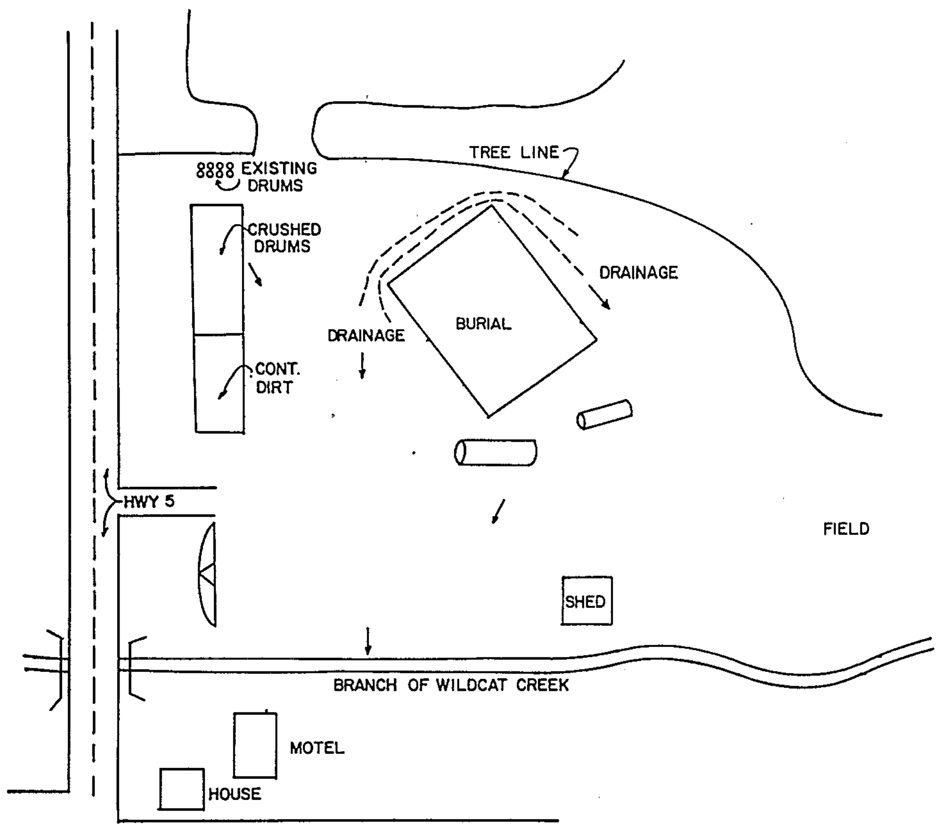


Figure 8-3. Site layout after remedial action at the Ferguson property. [8-1]

TABLE 8-2. COST OF CONTAINMENT REMEDIAL MEASURES AT FERGUSON PROPERTY [8-3]

	Expenditures by Region IV EEB		
Item	1/21/80-1/28/80	3/12/80-3/29/80	Total
Labor and other expenses	$31,056	$56,259	$ 87,315
Per Diem	3,640	6,232	9,872
Subcontractor: (subcontractor and rental equipment)	17,844	22,968	40,812
Miscellaneous (stone, seed, sawdust, plastic, etc.)	2,512	2,667	5,179
Total	$55,052	$88.126	$143,178

CONCLUSION

When the environmental problems at the Ferguson property were first discovered in 1976, SCDHEC tried to persuade both parties to remove the corroded, leaking drums containing flammable chemicals. Neither the Ferguson heirs nor ICC were willing to meet together and discuss and resolve the problem. SCHEC did not have legal power to force removal of the drums. There were no regulations governing how hazardous wastes could properly be disposed.

Since neither the landowner nor ICC would accept voluntary responsibility for the barrels, EPA resorted to 311 action to contain the site for a two to four year period. It was believed that the temporary cleanup measures as outlined by EEB would keep the cost down and would allow pressure to be maintained on one or both parties to achieve permanent disposal of the barrels. However, the first measures instituted by EEB were not adequate. EEB was required to return to the site, remove the solvents, and crush the drums. The solvents were sent to a solvent reclaimer. The crushed drums, solids, and contaminated soil were all buried. The site was then regraded, diversion ditches were installed, and the area was seeded.

The total cost of the two temporary corrective actions was approximately $143,000. Both actions were to ensure no seepage problem occurred while the State legally determined the responsible party. The State is responsible for ensuring completion of permanent cleanup actions once the responsible party is determined. Permanent cleanup would include removal of the remaining solvent waste (i.e., drummed solvent waste and the oil sludge waste located in the tanks).

SITE G REFERENCES AND BIBLIOGRAPHY

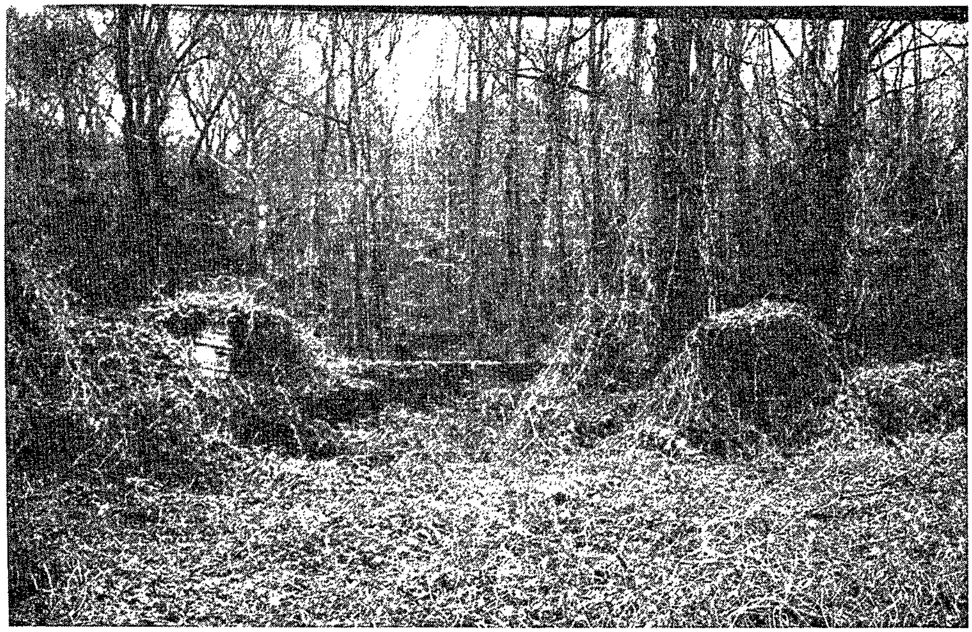
8-1 Personal communication and file review with Gary Hogue, Environmental Quality Manager, Catawba District, South Carolina Department of Health and Environmental Control, Fort Lawn, South Carolina. June 13, 1980.

8-2 Personal communication and file review with Joe Young, U.S. Environmental Protection Agency, Region IV, Residual Management Branch, Atlanta, Georgia. May and June 1980.

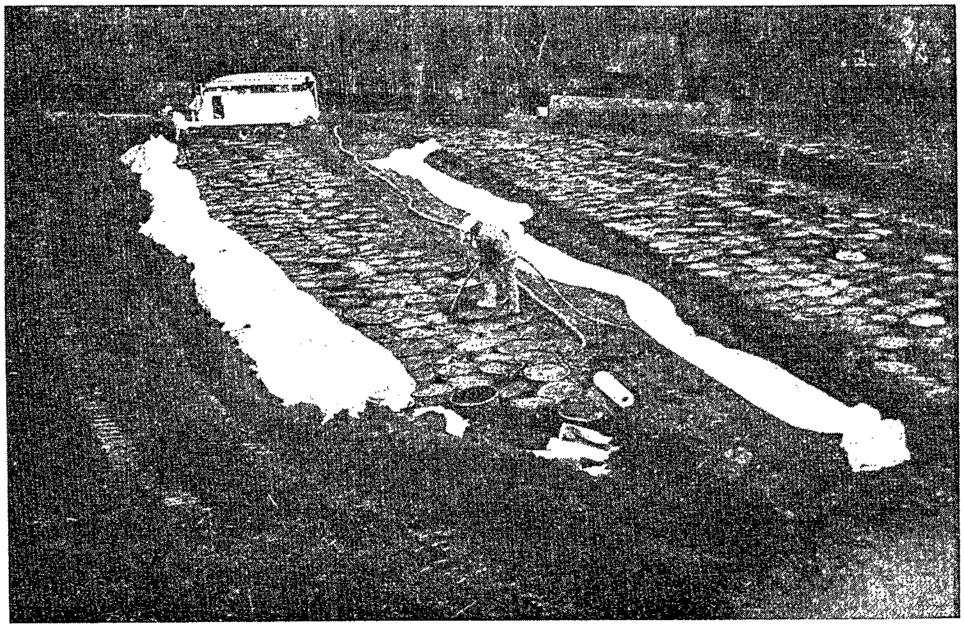
8-3 Personal communication with Jan Rogers, U.S. Environmental Protection Agency, Region IV, Environmental Emergency Branch, Atlanta, Georgia. May, June, and July 1980.

APPENDIX 8-1

SITE G PHOTOGRAPHS



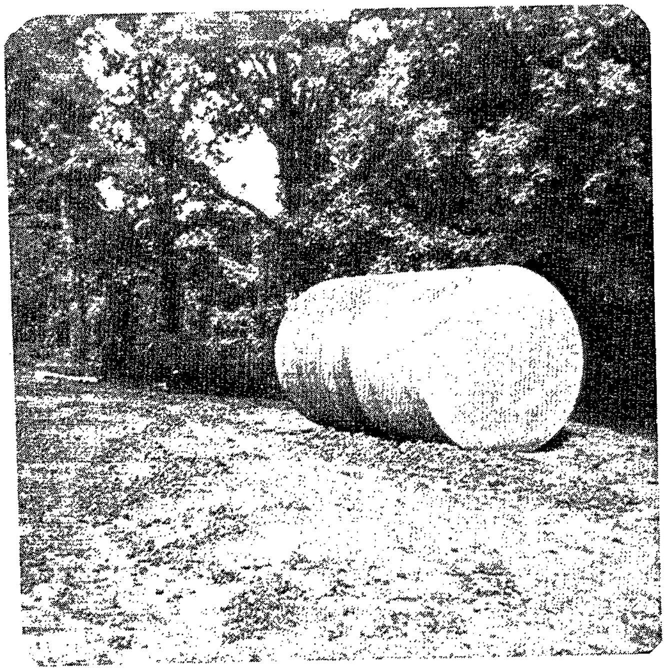
Site appearance prior to any remedial action.



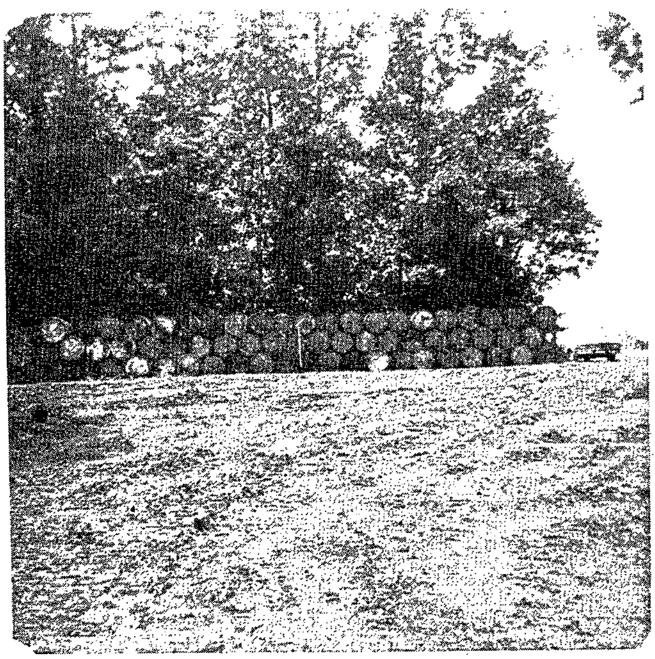
During the first applied remedial action the drums were placed in trenches and a plastic liner placed on top prior to soil addition.

Burial area following second cleanup.

Drainage diversion ditches around burial site.



38 m^3 (10,000 gal) barrel containing solvent sludge remaining at site pending further cleanup.



Approximately 70 barrels in good condition left at site pending further cleanup.

SECTION 9

SITE H
3M COMPANY
WOODBURY, MINNESOTA

INTRODUCTION

From 1960 until 1966, spent solvents and acids from the Minnesota Mining and Manufacturing (3M) Chemolite and St. Paul scotch tape, sandpaper, and chemical manufacturing operations were disposed in pits at a site in Woodbury Township, Minnesota. In May 1966, a nearby private well was found to be contaminated with isopropyl ether, an organic solvent. Subsequently, disposal in the pits was discontinued and comprehensive monitoring of other wells in the area initiated. Based on the data collected, it was determined that only the one originally affected well had been contaminated with organic solvents.

In January 1968, the waste in the pits was removed and burned on-site. Between 1966 and 1971, solvent waste produced by 3M was sent to incinerator facilities off-site. Better controls were then exercised over in-house operations to reduce the amount of waste requiring disposal. In 1971, an incinerator was constructed on-site by 3M to dispose of waste solvents.

To prevent further migration of pollutants in the ground water, four barrier wells were installed at the Woodbury site. These wells are pumped continuously, and discharged to the Mississippi River. Monitoring data collected since implementation of these actions indicates that the barrier wells are effective in preventing further contaminant migration.

SITE DESCRIPTION

Figure 9-1 shows the location of 3M's Woodbury disposal site in relation to Chemolite, Minneapolis, St. Paul, and the Mississippi River. The 3M Woodbury disposal facility is located on the eastern side of the Twin Cities Metropolitan Area. The 3M Chemolite manufacturing facility which provided a major portion of the waste disposed at the Woodbury site, is located about 6 km (4 mi) south of the Woodbury disposal facility.

The normal annual precipitation for the area is 66 cm (26 in.) and the normal annual snowfall is 117 cm (46 in.). The average wind speed is 16.9 kph (10.5 mph). The annual daily maximum temperature is approximately 12^{o}C (54^{o}F) with the monthly high occurring in July at 28^{o}C (82.4^{o}F), and lowest in January at -6^{o}C (21.2^{o}F).

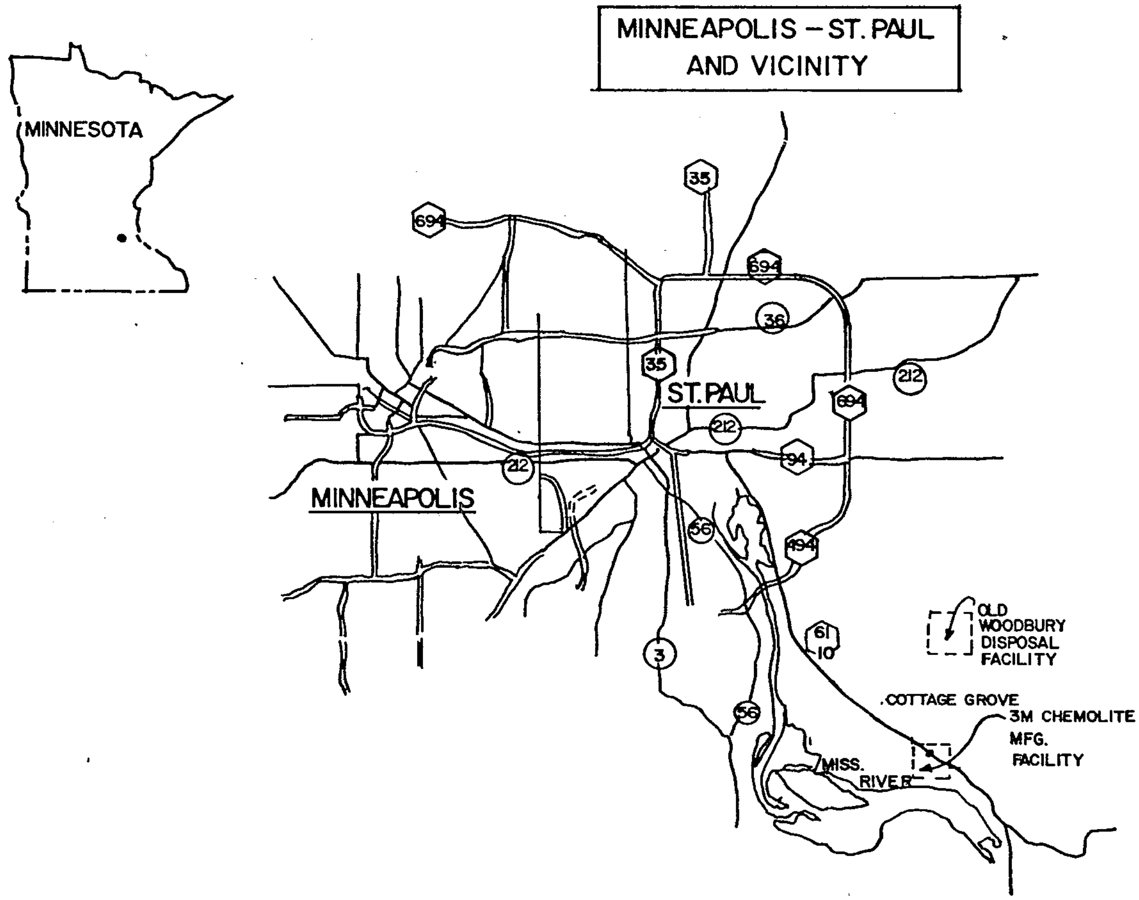


Figure 9-1. Location of 3M disposal site in Woodbury, Minnesota.

The geology in the area consists of Paleozoic bedrock overlain by glacial drift averaging 15 to 30 m (50 to 100 ft) thick. The site lies in a buried glacial valley. During an earlier time period, the valley was apparently cut by a tributary which fed into the nearby Mississippi River. The channel was subsequently filled with sand and gravel from more recent glaciation. The buried bedrock channel trends in a northwest to southeast direction and was carved out of the Shakopee-Oneota and Jordan Formation.

Beneath the glacial outwash, Platteville Limestone, a medium dense gray shaley limestone, overlays the St. Peter Sandstone. The St. Peter Sandstone in turn overlays the Shakopee-Oneota Dolomite, which overlies the Jordan Sandstone. The Shakopee Dolomite contains fractures possibly created by previous glacial loadings. The pits at the Woodbury disposal site are located in the glacial outwash over the Shakopee Dolomite. Therefore, it is speculated that if any contaminants reached the Shakopee, easy access would be provided to the underlying Jordan Aquifer.

The outwash glacial material in the area is typically clay and gravel. The soil is a sandy loam provided by the glacial material and is reasonably fertile. The limestone provides an alkaline pH to the soil. The soil lends itself to drought conditions due to its sandy nature. The topography of the area is also influenced by previous glacial movements. The land is slightly rolling to flat with only minor ravine systems.

There are no drainage creeks or rivers in the immediate site area since the glacial till acts as a sponge. The surface drainage of the Twin Cities area consists of potholes, swamps, lakes, and a few small river tributaries to the Mississippi and Minnesota Rivers. Due to the nature of the glacial drift, drainage channels appear for only a short distance before terminating in marsh areas. The only significant drainage rivers in the area are the Mississippi and Minnesota.

The primary commercial and residential water supply for the area is ground water. The Jordan Aquifer supplies water for industries in the Twin Cities area. Prior to installation of the barrier wells, two bodies of ground water existed under the pits in Woodbury: perched water and the Jordan Aquifer. Figure 9-2 displays a generalized geological cross section of the area beneath the site. Previous to barrier well installation, the perched water located in the glacial drift below the pits supplied water to shallow wells in the area. However, within three years after barrier well installation, all perched ground water in the glacial till had dissipated. Thus, the only ground water body now located beneath the old pit area is the Jordan Aquifer. While it existed, perched water in the glacial

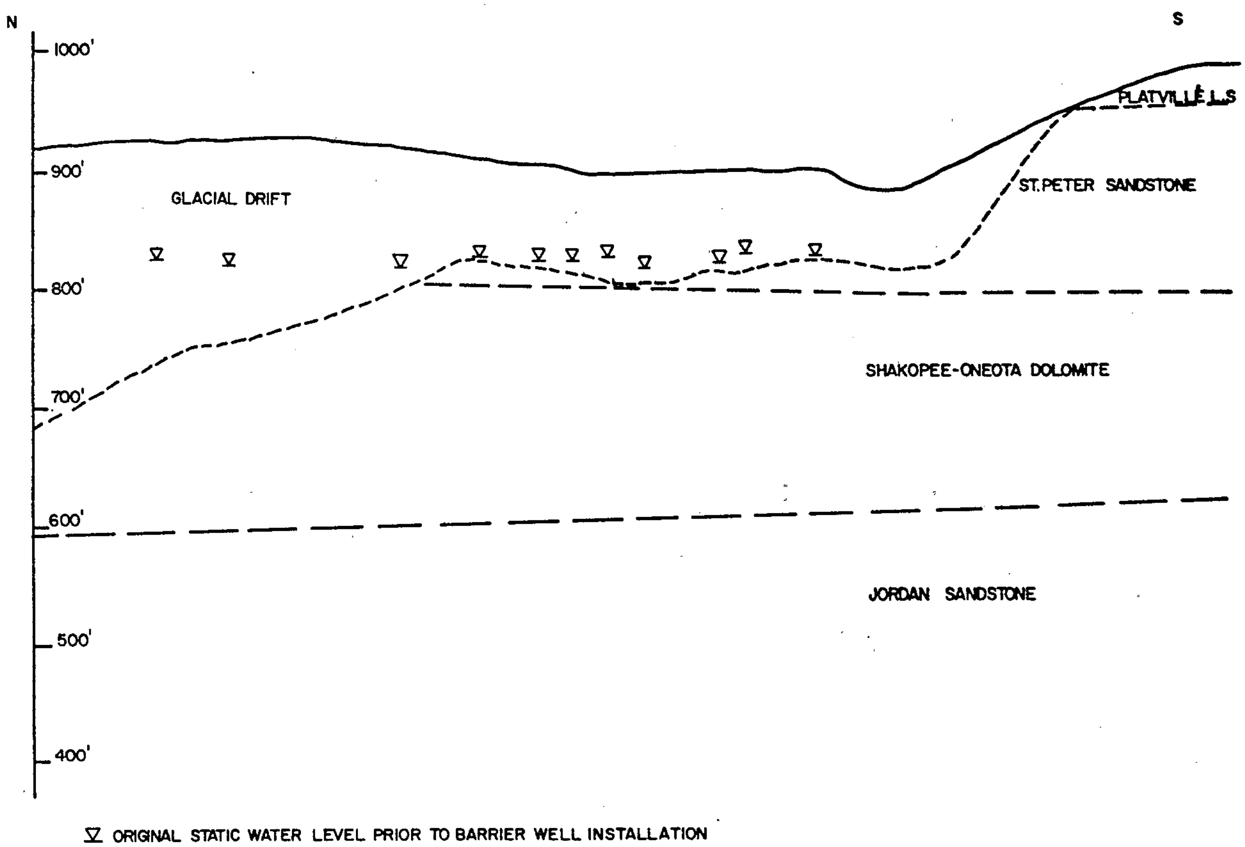


Figure 9-2. Geological cross section of area beneath Woodbury disposal site. [9-1]

drift tended to flow southwestward to south toward the Mississippi River. The Jordan Aquifer, however, flows northwest from the site toward Minneapolis and St. Paul.

SITE OPERATION AND HISTORY

In 1960, Terminal Warehouse purchased 12 to 16 ha (30 to 40 ac) of farmland in Woodbury, Minnesota for use as a waste disposal site. Wastes from 3M manufacturing plants were hauled and disposed by Terminal Warehouse in unlined lagoons (pits) at the Woodbury site. In August 1961, 3M purchased the land from Terminal Warehouse and continued to use it for disposal of waste from their Chemolite plant (located in Cottage Grove, Minnesota) and downtown St. Paul facility. Pits on the property were used by 3M for dispsoal of spent solvents, sludges, and solid wastes (e.g., scrap plastic). 3M also permitted Woodbury Township to dispose their municipal waste in the southeast corner of the property. Figure 9-3 shows the location of the pits at the Woodbury site. The small amount of Woodbury municipal waste disposed at the site was segregated and kept outside the pit areas used for solvent, acid, and facility waste of 3M.

Little is known about actual operations at the disposal site. No records were kept as to type and quantity of wastes disposed. It has been estimated that 153,000 m^3 (200,000 yd^3) of wastes were disposed in the area. The waste consisted of solvent contaminated material, adhesive, rolls of film, rags, resins, and off-specification materials. About 50 percent of the liquid waste consisted of an estimated 760 m^3 (200,000 gal) of isopropyl ether. It has also been estimated that 23,000 m^3 (6,000,000 gal) of wet scrap was disposed at the site.

The solvents deposited at the site had been used as carrier agents to maintain a fluid condition of the adhesives applied on scotch tape and sandpaper. The chief solvent used as a carrier agent was heptane. Other solvents used were acetone, isopropyl ether, and toluene. Highly flammable liquid waste was sent to a private incinerator facility in Newport, Minnesota. Less flammable liquid wastes and solid wastes not accepted by the Newport facility were placed in pits at the Woodbury site.

Prior to 1963, various acids, primarily sulfuric, were dumped in limestone pits at the site. In late 1963, the Minnesota Water Pollution Control Commission (MWPC) informed 3M that ground water contamination could occur as a result of their practices. They recommended that the dumping of acids be discontinued and that all other wastes be placed in clay pits. These recommendations were accepted and implemented by 3M. In 1963 a limestone pit was constructed at the Chemolite plant and disposal of acids was discontinued at the Woodbury facility.

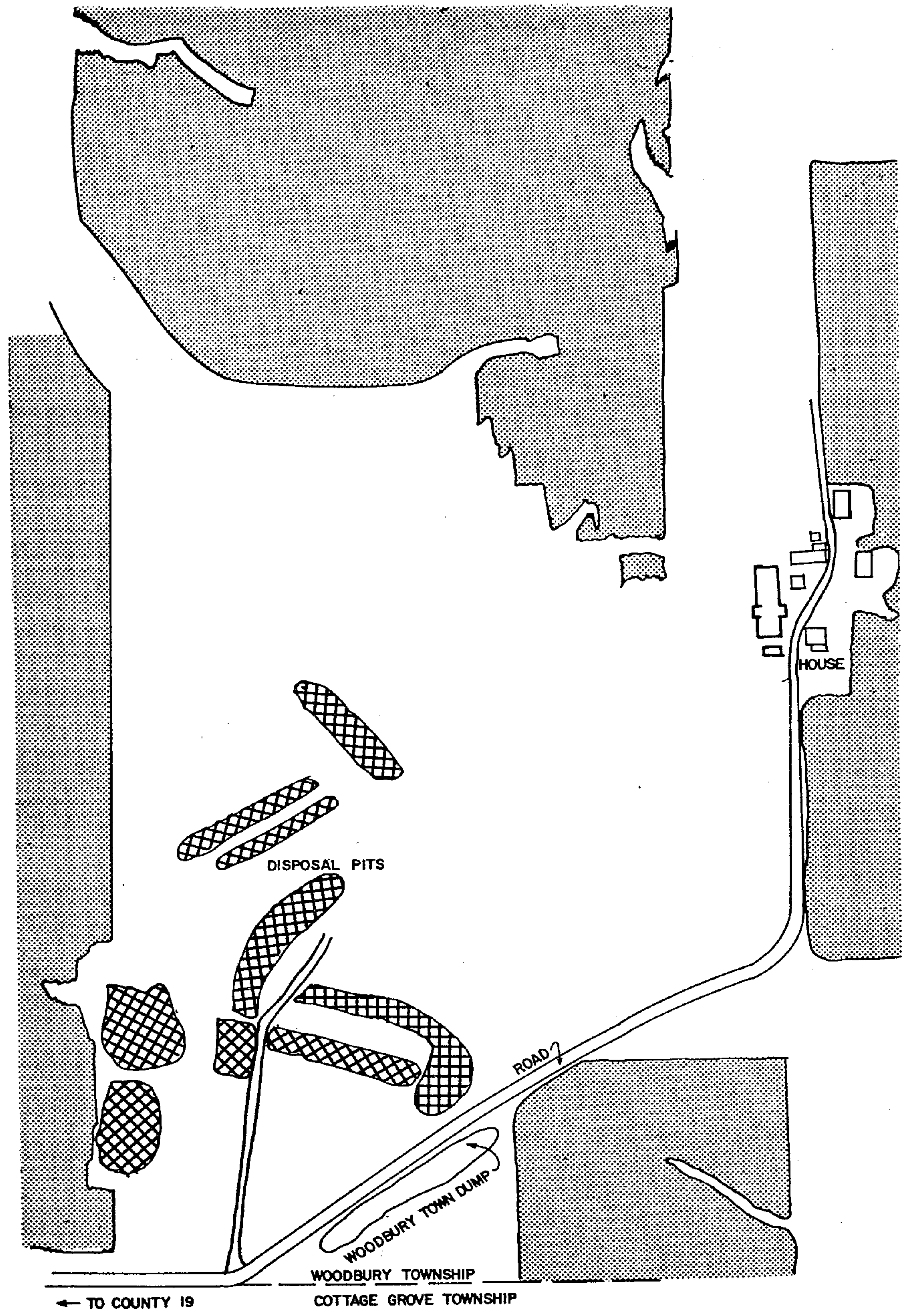


Figure 9-3. Configuration of waste disposal pits at 3M Woodbury site. [9-2]

When evidence of ground water contamination appeared in 1966, 3M stopped all disposal activities at the Woodbury site. Housekeeping practices were improved to decrease the amount of waste being discarded. Wet scrap was sent to Shakopee, Minnesota for incineration from 1966 to 1971. In July 1971, an incinerator was put into operation at the Chemolite plant facility.

POLLUTION

In May 1966, a private well near the site was found to be contaminated with isopropyl ether, one of the solvents disposed in the pits. Eighteen residential wells were sampled in Woodbury Township and Cottage Grove Village around the disposal area. Based on results obtained, it was determined that only the originally-identified well was contaminated; none of these other 18 wells had any trace of organic chemical contamination.

By August 1966, all the wells in the area had been sampled and use of the disposal site had been discontinued. A consulting engineering firm was retained by 3M to determine the extent of the problem and to recommend a solution. A 61 m (200 ft) deep, 30 cm (12 in.) diameter test well was drilled on September 13, 1966. Figure 9-4 locates the contaminated well (at the Schussler residence) in relation to the disposal site and the test hole (called Observation Well A). Drilling of the test well stopped at two levels in the glacial drift, three levels in the Shakopee-Oneota Dolomite, and one level in the Jordan Sandstone. Water samples were collected from each level for analysis. Water samples were also collected from two 3M existing 5 cm (2 in.) observation wells and the caretaker's well located at the disposal site. One of these is located in the northwest corner of the site, one in the southwest corner, and the caretaker's well is located east of the disposal area between the two observation wells. The observation wells bottom in the St. Peter Sandstone and their well screens are open to both glacial drift and sandstone.

Analysis on the wells showed contamination in the glacial drift and upper levels of the Shakopee-Oneota Dolomite at a depth of about 61 m (200 ft). Contamination was found to decrease substantially with increasing depth. Insignificant trace contaminants were detected in the Jordan Sandstone. Isopropyl ether was the major pollutant, with concentrations varying from 4 to 5 ppm in the shallow drift to less than 0.1 ppm at 47.5 to 61.0 m (156 to 200 ft).

Since confirmation of contamination in the upper ground water aquifer, regular monitoring of nearby, residential wells has been conducted. Ten area wells are now sampled once every two months by the Department of Health and 3M. Previously, 3M had sampled 52 wells in the surrounding neighborhood on a bi-monthly

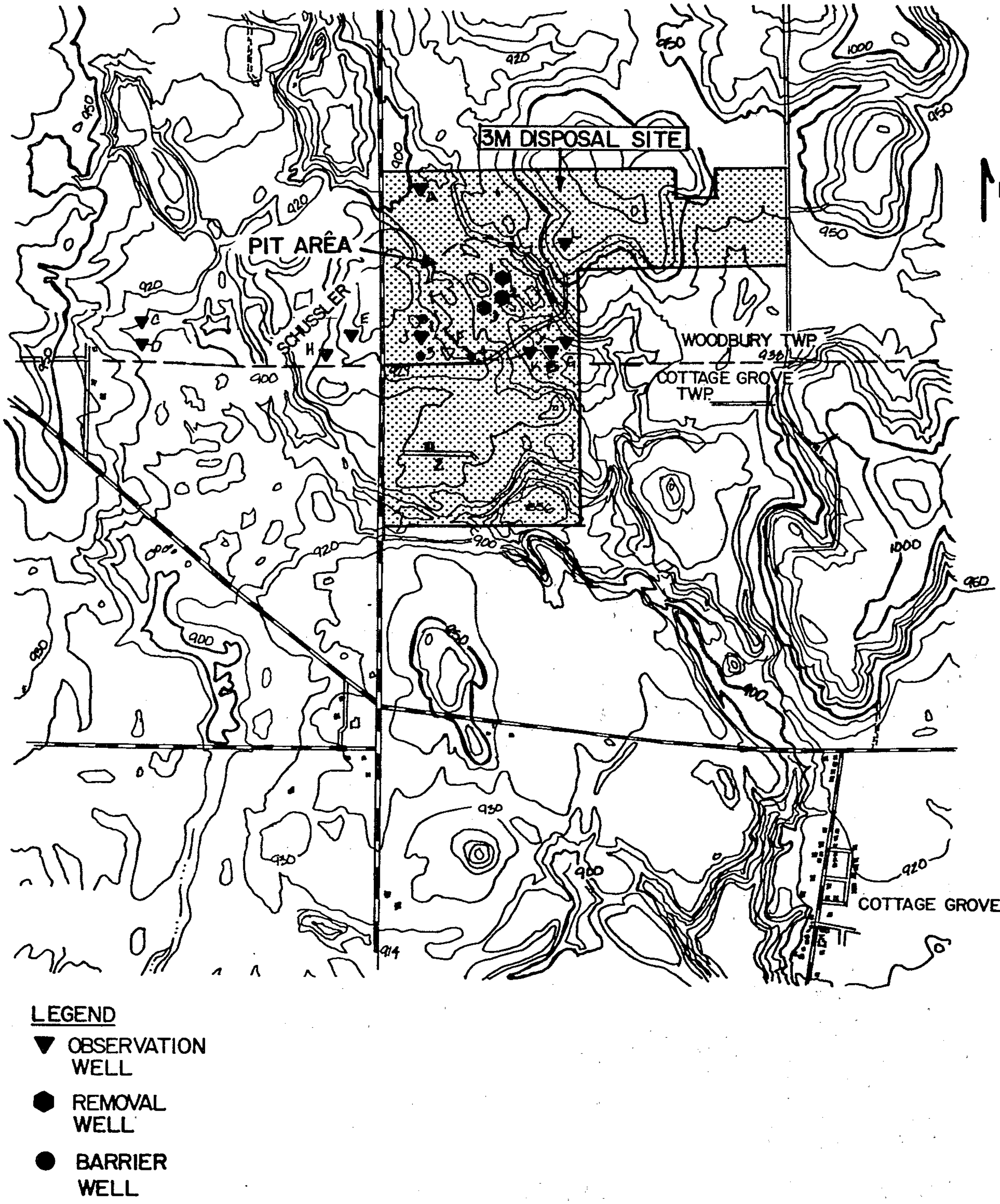


Figure 9-4. Location of contaminated Schussler well and barrier wells. [9-1, 9-3]

schedule. The 10 wells that are presently being sampled are located in glacial material and have shown no contamination except for nitrates from barnyard runoff. Schussler's well was the only well found to be contaminated with organics. As a result of barrier well water withdrawal, the glacial perched water was drained and Schussler's well went dry in about 1970. Subsequently, a new well was installed for the Schussler residence, which retrieves ground water from the Jordan Aquifer. Figure 9-5 exhibits the combined concentration of isopropyl ether and other compounds at the old shallow Schussler well. The new Schussler well has never shown any isopropyl ether contamination.

REMEDIAL ACTION

Based upon the determination that the major contaminants were located in the perched shallow ground water, the following remedial actions were initiated:

- All disposal activities at the site were discontinued.
- New waste was sent to an outside incinerator/disposal facility. In 1971, an incinerator was constructed at the Chemolite facility to burn acceptable wet scrap.
- Waste within the pits was removed and burned.
- Four barrier wells were installed to create cones of depression in the ground water down-gradient from the site. The effect of these cones of depression was to prevent contaminated ground water from migrating further down-gradient and to remove the ground water that had already been contaminated. The water thus removed was to be discharged directly to the Mississippi River.
- A regular monitoring program of residential wells in the immediate vicinity of the disposal site was instituted to detect contaminants in the ground water.

Several alternatives were considered for reducing and disposing the solvent and scrap waste located in the pits. For lack of other viable alternatives, it was decided that the waste would be excavated from the pits and open burned. It was postulated that a time limited, large-scale burning project would rid the pits of solvents judged to be the source of ground water contamination and would shorten the time necessary to return the ground water quality to acceptable levels.

A trial open cell test burn was conducted in August 1967. A drag line was used to excavate the waste from the pits. During the burning process, the drag line was used to mix the burning

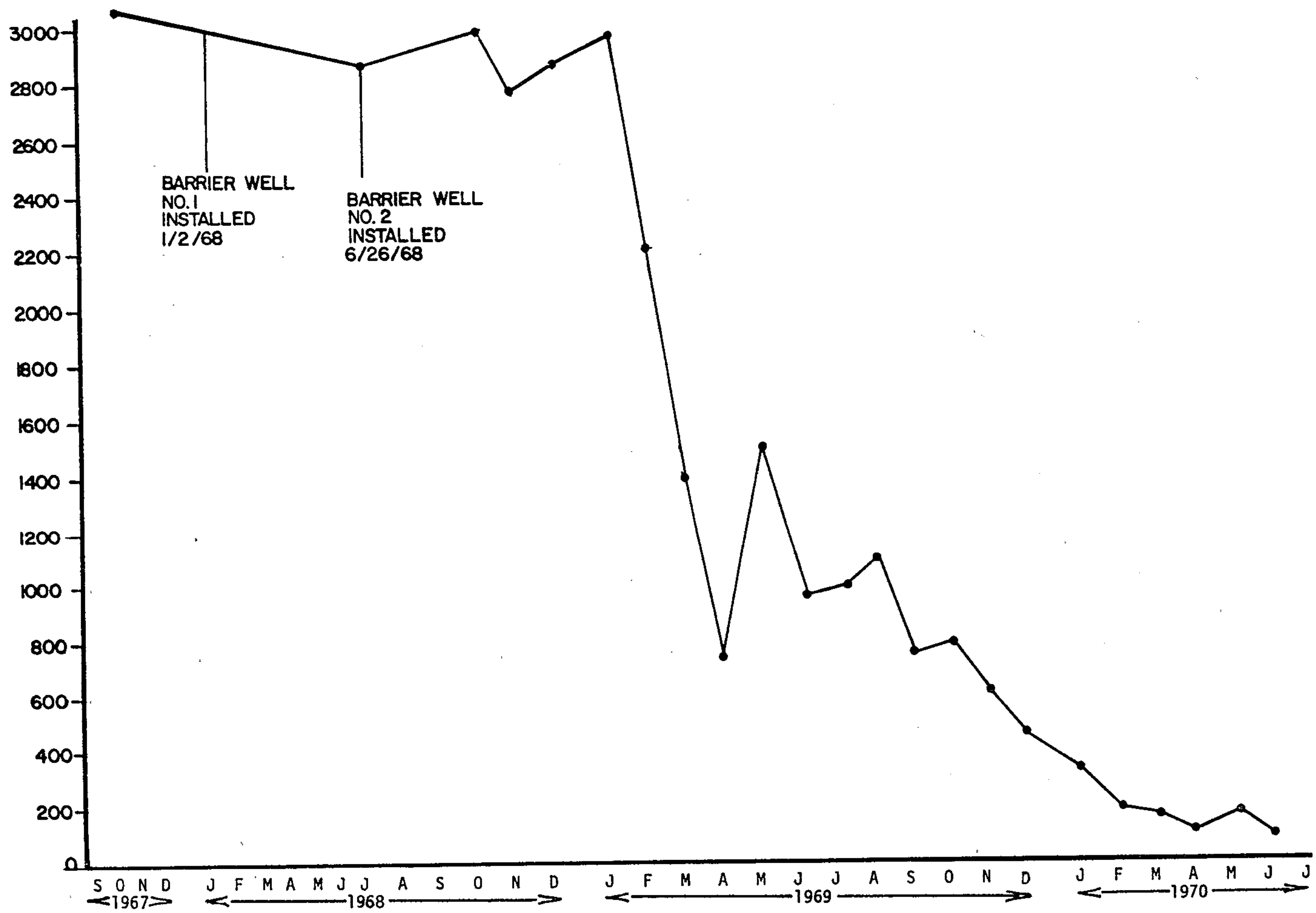


Figure 9-5. Sum of the concentration of isopropyl ether, isopropanol, and dichloromethane for shallow well at Schussler residence.

mass and to accelerate the burning efficiency. Following the test, samples of the remaining residue were collected for analysis. The volume of the waste subjected to the test burn had been reduced by 95 percent. Subsequently, the residue was soaked with water and no contaminants were dectected in the wash water. As an extra precaution, the burned residue was placed above ground, diked, and observed over a period of time before burying it.

Based on good results obtained from the test burn, 3M obtained permission from Woodbury and Cottage Grove for full-scale burning of all wastes. Burning was conducted in January 1968 to take advantage of the good air quality, low temperatures, and low vapor pressure. Burning was conducted continuously until all waste had been burned. It is estimated that 153,000 m^3 (200,000 yd^3) of waste was burned during this period. During the burning the air was monitored with a network of fixed sampling stations and one mobile station. Four fixed stations were placed near residences on each of the four sides of the property; one fixed station was placed in the Village of Cottage Grove. The mobile unit, provided by the City of St. Paul, sampled at various locations in the burning area. Air was monitored for carbon dioxide, sulfur dioxide, suspended particulate matter, and settleable particulares. A weather station located near the burn area provided data on wind direction, speed, and ambient temperatures.

Although a significant amount of smoke was generated during the burning, excessive concentrations of air pollutants were not detected by the monitoring stations. Occassionally a slight odor was noticed at one of the sampling stations, and as the intensity of the odor increased, the burning was reduced. The air monitoring program carried out during the burning period by 3M did not indicate any potential health or vegetation damage. Growth tests were conducted on collected ash in the air sampling network to determine the composition and effect of the ash fallout on future vegetation. The ash was basically carbonaceous and it was determined that it would not adversely effect vegetation in this area.

Once the burning was completed, the remaining residue (metal, ceramic scrap, etc.) and ashwall was piled above ground, diked, and observed for a period of time, and then buried in the pits. The waste was reduced by more than 99 percent. Vegetation was then allowed to take root naturally. Native grasses and trees now cover most of the land and only minor erosion-worn areas are noticeable. 3M personnel have chosen not to fill the pits, claiming that this allows rainwater to accumulate and subsequently percolate downward, in the process, flushing contaminants in the soil to the ground water. Once in the ground water, these can be extracted by the barrier wells.

Based upon a hydrologic study, it was determined that contamination was confined to shallow depths in one direction from the disposal area, with the Schussler being at the leading edge of contaminant migration. Therefore, barrier wells designed to operate continuously were installed to prevent further contaminant migration and remove existing contamination from the ground water. The first barrier well (No. 1) went into operation in January 1968; the last barrier well (No. 4) went into operation in 1974. Barrier Wells 1 and 3 withdraw water from the Jordan Aquifer. Ground water in the Jordan Aquifer is not contaminated and is used to dilute the contaminated water from the perched ground water withdrawn by Barrier Wells 2 and 4. The four wells withdraw a monthly average of 0.16 m^3/sec (3.6 mgd). Originally, water from Barrier Well 1 was recycled back to the excavated disposal pits to flush contaminants lodging in the soil; this practice has since been discontinued.

Presently, approximately 60 percent of the withdrawn water from the Woodbury site is used at the Chemolite plant as non-contact cooling water. The remainder of the withdrawn water is discharged directly to the Mississippi River.

Table 9-1 provides performance data on the four barrier wells. (The location of these wells was shown in Figure 9-4.) Figure 9-6 demonstrates that a decrease in concentration of isopropyl ether has been experienced since the introduction of the barrier wells. Table 9-2 displays 19 priority pollutants which were found in the discharge water. The discharge system consists of a 10 km (6 mi) underground forcemain privately owned by 3M and which allows effluent discharge into the Mississippi River. The forcemain consists of 5,000 m (16,400 ft) of 46 cm (18 in.) diameter iron pipe and 3,286 m (10,782 ft) of 46 cm (18 in.) diameter asbestos cement pipe. After pumping water through the forcemain, the water flows down-gradient to the Chemolite facility, and is discharged into a ravine which empties into the Mississippi River.

The barrier wells are expected to operate indefinitely since they now serve another function as a supply of cooling water. Pumping is continuous. When the wells were first installed, power failure due to electrical storms occurred frequently shutting the pumps off. To correct the problem, the pumping station was automated and a telephone circuit installed to relay problem information to the Chemolite personnel. The systems are checked once each day.

Initial attempts to use the withdrawn water resulted in build-up of iron oxide, manganese oxide, and iron bearing bacterial slime in the piping. As a corrective measure, chlorine is added initially to the well discharge to inhibit iron reducing bacteria and a stabilizing chemical (Nalco 345) added to prevent precipi-

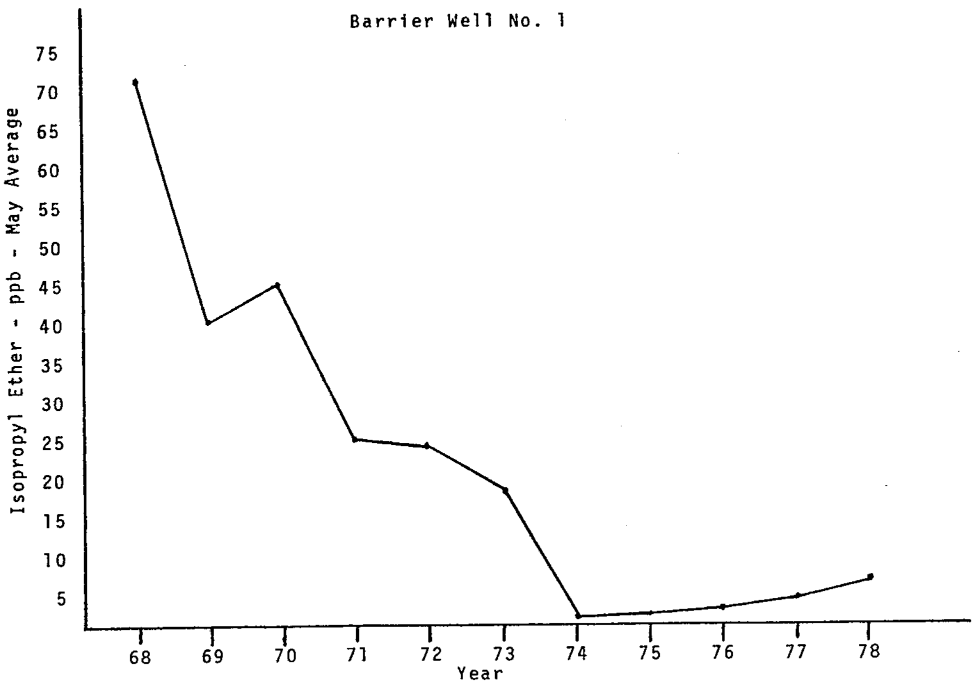
TABLE 9-1. HORSEPOWER AND DISCHARGE OF BARRIER WELLS

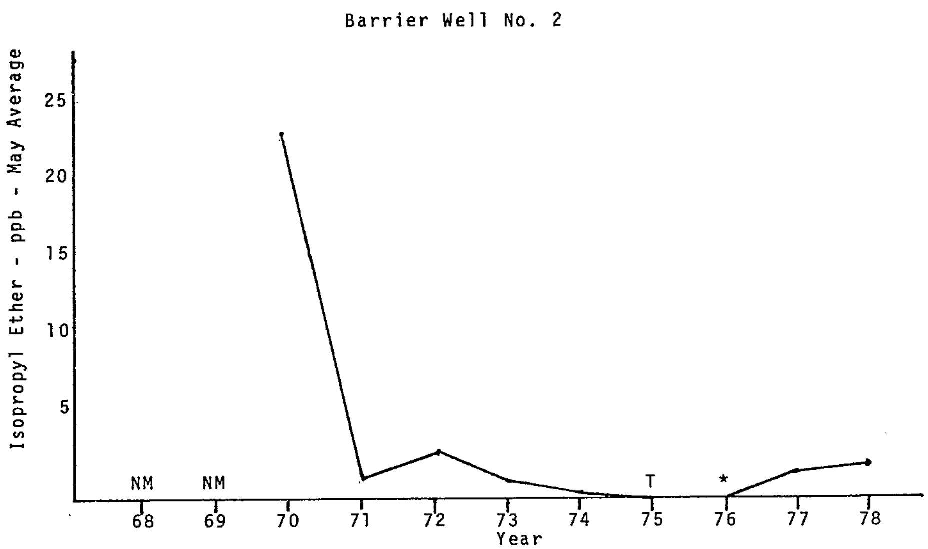
Well No.	Motor Horsepower	Average Discharge (m^3/min)
1	75	0.38
2	40	2.65
3	50	1.89
4	125	4.54

1 m^3/min = 264.2 gal/min

TABLE 9-2. 3M WOODBURY WELLS PRIORITY POLLUTANT SAMPLING RESULTS

Priority Pollutant	Concentration (ug/l)
Benzene	1
1,2-Dichloroethene	3
1,1,1-Trichloroethane	1
1,1-Dichloroethane	3
1,1,2-Trichloroethane	4
2,4,6-Trichlorophenol	1
Parachlorometa cresol	1
Chloroform	5
Ethylbenzene	4
Methylene Chloride	8
Phenol	<1
Bis (2-ethylhexyl) Phthalate	9
Diethyl Phthalate	2
Toluene	2
Trichloroethylene	1
Endosulfan-Alpha	<0.01
Endrin Aldehyde	0.14
Heptachlor Epoxide	<0.01
BHC-Alpha	<0.01

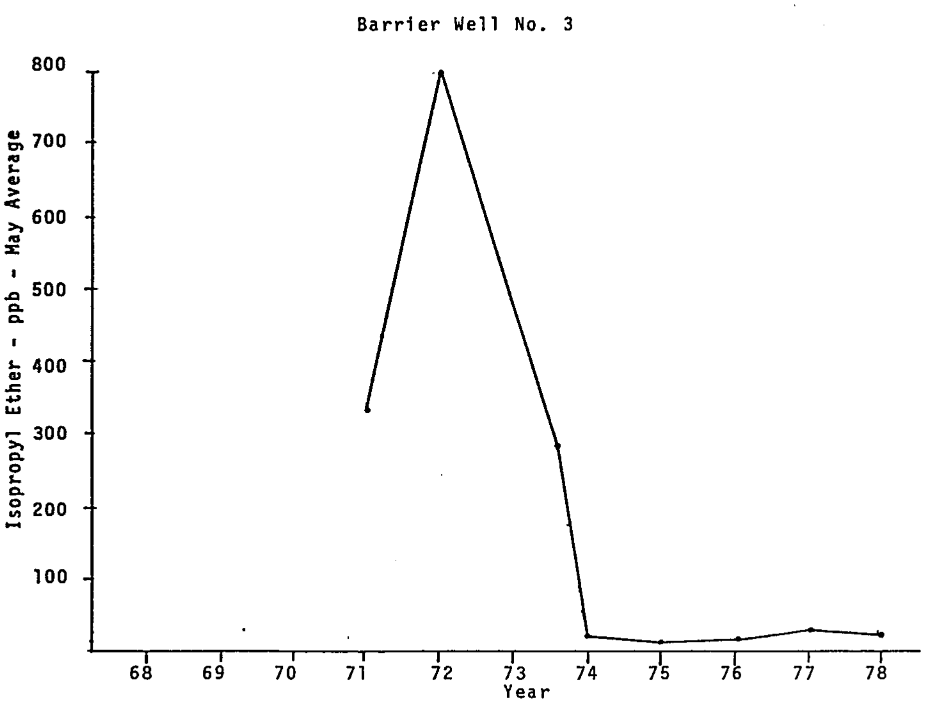


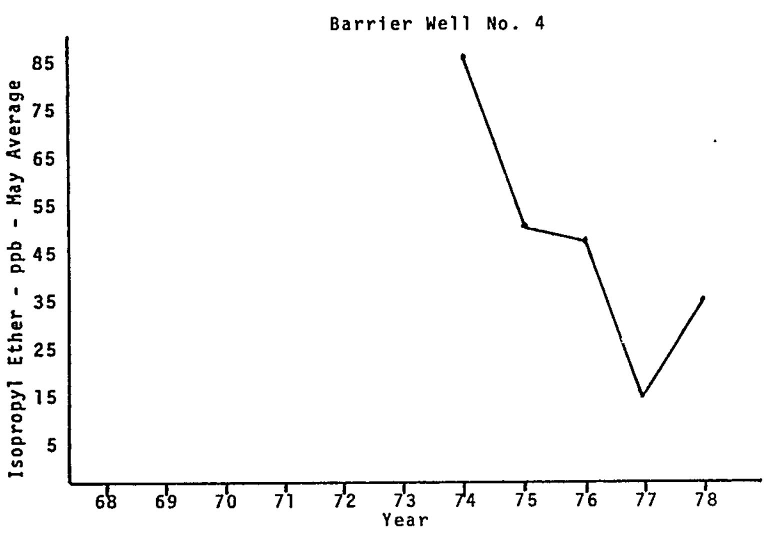


NM = Not measureable
T = Trace
* = No peaks observed

Figure 9-6. Graphs of isopropyl ether measurements for Barrier Wells Nos. 1 to 4.

Figure 9-6 (Continued)





tation of iron and manganese oxides. To prevent discharge of chlorine into the Mississippi River, the withdrawn chlorinated well water is dechlorinated with sulfur dioxide prior to discharge.

In 1972, a $4.6 million incinerator was constructed at 3M Chemolite to burn industrial liquid and semi-liquid chemical wastes which had previously been placed in pits at the Woodbury disposal site. The incineration system includes a large materials handling building, five 38 m^3 (10,000 gal) tanks for liquid waste storage, a specially designed feed system for 0.21 m^3 (55 gal) drums, a large rotary kiln with secondary combustion chamber, high energy Venturi scrubber for air pollution control, wastewater treatment facility, and a 60 m (200 ft) high discharge stack.

Not counting the amount spent on development and operation of the incinerator, 3M has spent over $7 million dollars to date in correcting environmental problems at the Woodbury disposal site. In addition, approximately $95,000 is spent annually on continued operation of the barrier well system.

CONCLUSION

When ground water contamination was first identified at the Woodbury 3M facility, 3M immediately took responsible actions to mitigate and correct the problem. Previous practices were stopped, an investigation was undertaken to determine the extent of the problem, and corrective actions were initiated.

Within one and a half years, the waste had been removed from the pits and burned. It should be noted that it is unlikely that such open burning would be allowed under current air quality regulations. However, the Minnesota Pollution Control Agency had not formulated an air control policy at the time of the burning, and had neither established a permitting system nor promulgated air pollution regulations. At the time, a burning operation was selected as the best method of disposing of the solvents causing the ground water contamination.

The use of four barrier wells appears to have effectively reduced the migration of contaminants from the area. Presently, 3M uses some of the withdrawn water as a non-contact coolant and, therefore, has chosen to derive benefits from money spent on a system used to correct a pollutant problem.

In general, the Minnesota Pollution Control Agency has been pleased with the efforts and prompt action of 3M and believes that the barrier well system is an appropriate corrective action. Likewise, good public relations exist between 3M and the Town of Woodbury and Village of Cottage Grove and several public meetings have been conducted over the years to discuss the problem.

SITE H BIBLIOGRAPHY AND REFERENCES

9-1 Personal communication with Russel Susag, Millard Goldsmith, and Michael Santoro, 3M, St. Paul, Minnesota, June 26, 1980.

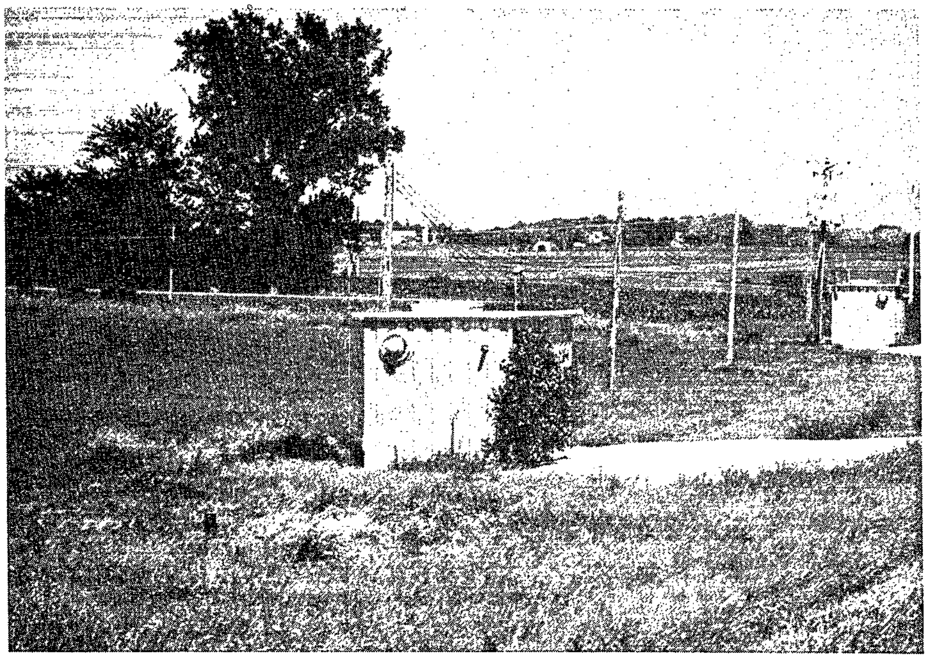
9-2 Clarified aerial photo, S1/2 Section 35T 28N R 21W, Washington County. G-209 Mark Hurd Aerial Survey, Inc. April 1976.

9-3 Personal communication and file review with Gary Kimball, Minnesota Pollution Control Agency, Division of Water Quality, Permits Section, Roseville, Minnesota. June 25 and 27, 1980.

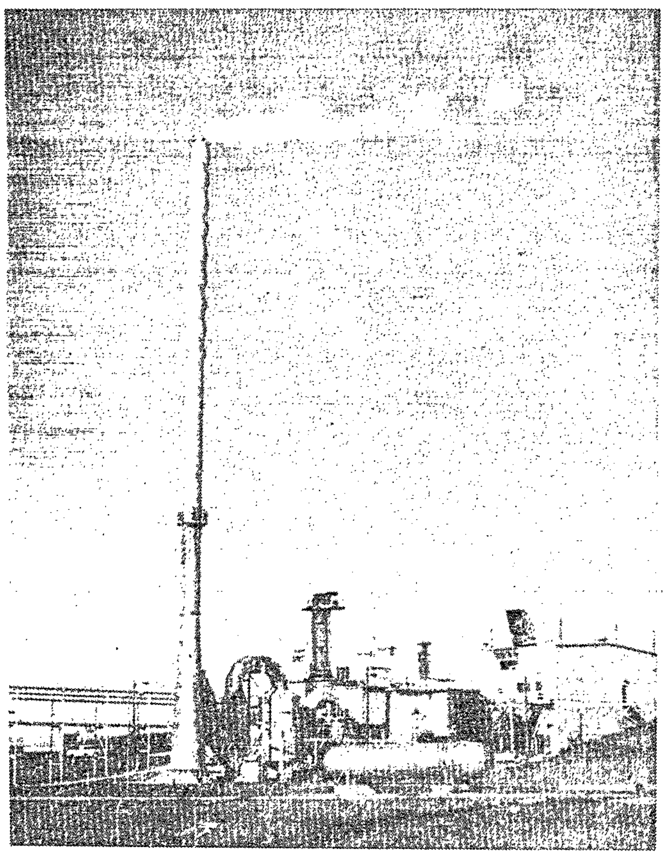
APPENDIX 9-1

SITE H PHOTOGRAPHS

Overall appearance of excavated pit area
at Woodbury Disposal pits



The structure in the middle of the photo shelters one of the barrier pumps



3M's Chemolite Incinerator

SECTION 10

SITE I
WHITEHOUSE/ALLIED PETROLEUM
JACKSONVILLE, FLORIDA

INTRODUCTION

Seven waste oil pits near Whitehouse, Florida have been a surface and ground water pollution problem for many years. Allied Petroleum Products Company, a waste oil reclaimer, constructed the first of these pits in 1958. The pits were used for the disposal of waste oils for about ten years. In 1969, Allied abandoned the pits and filed for bankruptcy. Subsequently, the City of Jacksonville moved to reinforce the earthen dikes around the ponds and built a limestone filtering system for the water in the pits to prevent pollution problems. However, due to budget constraints the City was forced to discontinue further remedial measures in 1975.

One of the pits ruptured in June 1976, spilling its contents onto an adjacent property and into a creek. After the spill, analyses conducted by the U.S. Environmental Protection Agency (EPA) on the remaining oil showed that the PCB concentration exceeded the federal discharge limit of 1 ppb. Subsequently, EPA, State of Florida, and City officials developed a comprehensive plan to dispose of the remaining oil and pollutants including (1) immobilization of the oil on-site to prevent further spillage, and (2) drainage of the ponded oils through an on-site treatment system to maintain PCB concentrations in site effluents at less than 1 ppb.

After dewatering, treated soils were mixed with the remaining sludge to combine with the oily matter. Next a layer of packing material, consisting of a foam rubber and upholstery material from car seats and other dry material, were layered on top of this mixture. Finally, a layer of fill dirt was used to cover the area. Subsequent remedial actions performed during the summer of 1980, included covering the site with impermeable soil, revegetating the site, rerouting drainage, and creating a fence or barrier to restrict public access.

SITE DESCRIPTION

The Whitehouse/Allied Petroleum site is located in Duval County in northeastern Florida approximately 16 km (10 mi) west of downtown Jacksonville. The site is situated between Machelle Drive and Chaffee Road north of U.S. Highway 90. The site consisted of seven pits covering a combined area of approximately

24,000 m^2 or 2.5 ha (250,000 ft^2 or 6 ac). The alignment of the seven pits was in an east-west direction with estimated depths from 1.5 to 4.6 m (5 to 15 ft). The location and layout of the site are shown in Figures 10-1, 10-2, and 10-3.

The climate of Jacksonville and vicinity is humid subtropical with warm, wet summers and mild, relatively dry winters. The average annual temperature is 20°C (68°F) and the average annual precipitation is 138 cm (54 in.), most of this in late spring or early summer. The average annual snowfall is a trace.

The topography of Duval County is mostly low, gentle to flat, and composed of a series of ancient marine terraces. Surface drainage from the site occurs through two drainage ditches which surround the site on three sides. These drainage ditches combine with McGirts Creek which empties into the St. Johns River approximately 16 km (10 mi) southeast of the site. The area in the vicinity of the site is rural to residential. There is some agriculture in the area, but most of the land is forested with pine trees harvested for pulp production. The elevation of the site is approximately 23 m (75 ft) above sea level.

The principal aquifer for municipal, industrial, and domestic water supplies in the area of the Whitehouse site is a sequence of permeable limestones known as the Floridan Aquifer. Overlying the Floridan Aquifer from a depth of 30 to 160 m (100 to 525 ft) are confined or secondary aquifers in clays, sands, and limestones of the Hawthorn Formation. The water table or unconfined aquifer in undifferentiated Plio-Pleistocene deposits consists of alternating beds of sand, clay, and sandy clay to a depth of about 0 to 30 m (0 to 100 ft). The water table and secondary aquifers of the Hawthorn Formation are used primarily for domestic purposes. At Whitehouse, the water table is generally within 1.5 m (5 ft) of the land surface and the potentiometric surface of the Floridan Aquifer is about 13 m (43 ft) above sea level or 9 m (30 ft) below the land surface. Ground water flow for the water table is to the west towards McGirts Creek. A well log of the subsurface at the Whitehouse site is provided in Appendix 10-1.

SITE HISTORY AND POLLUTION

The Whitehouse/Allied Petroleum oil pits were operational between 1958 and 1968. They were used during this period as a disposal site by the Allied Petroleum Products Company, a waste oil reclaimer, for the disposal of acid sludges, clay wastes, and waste oils from their processes. The Company used oil, such as used motor and transformer oil, for their crude. This crude was acid- and clay-treated to produce a motor oil and the waste from this operation was dumped into the pits. The seven waste oil pits were abandoned in 1969 when the Company went bankrupt. The City of Jacksonville acquired a third of the property by tax default.

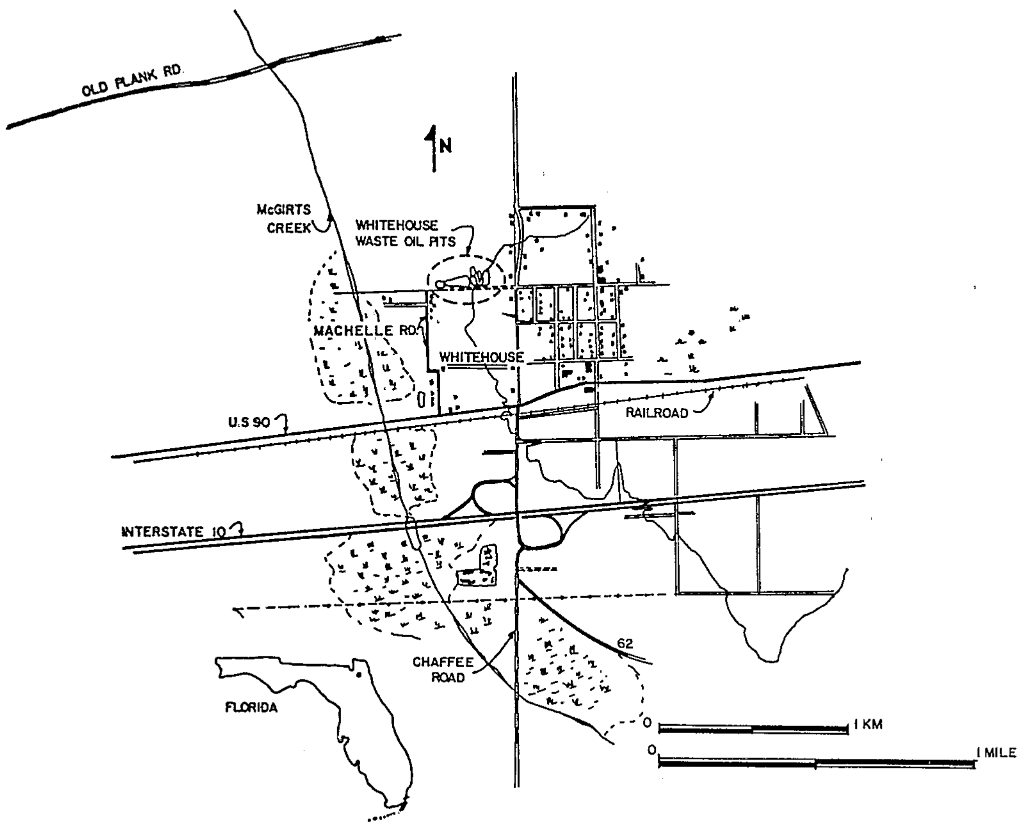


Figure 10-1. Location of Whitehouse/Allied Petroleum site.

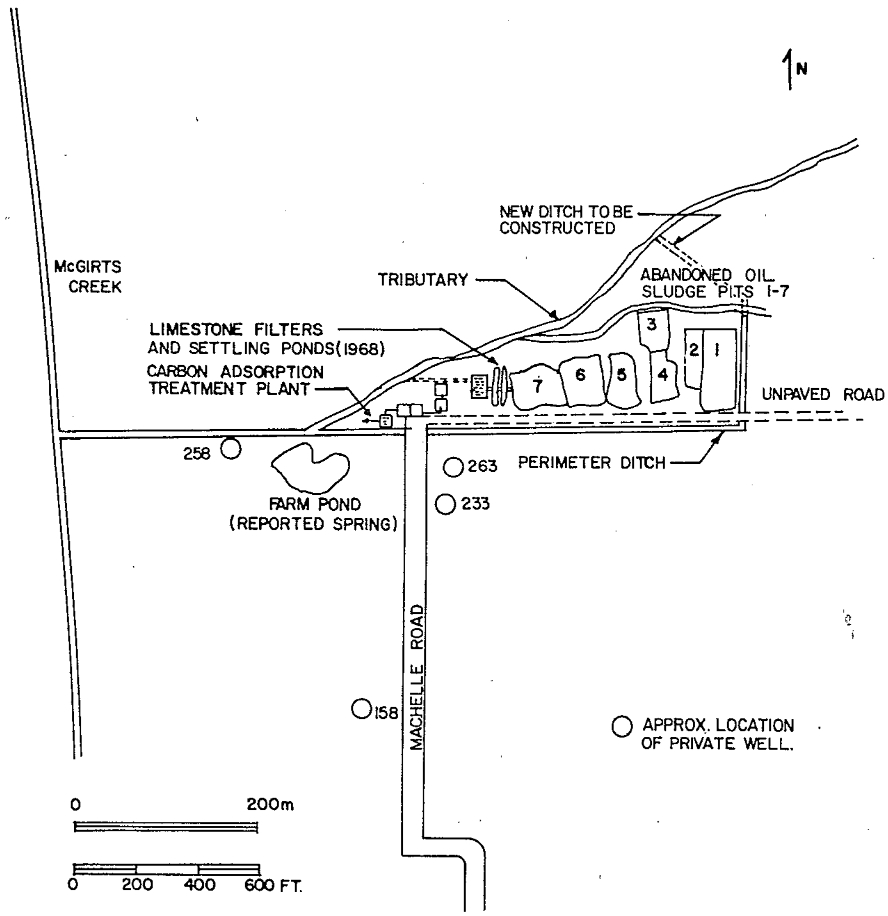


Figure 10-2. Layout of Whitehouse oil pits (1976).

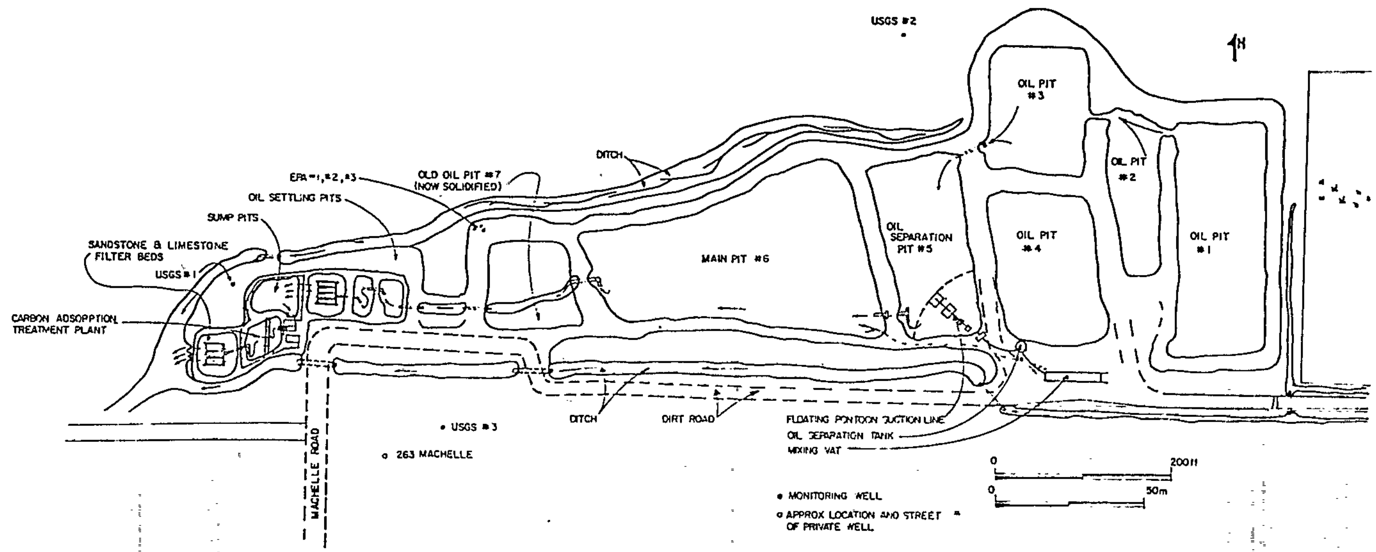


Figure 10-3. Layout of Whitehouse oil pits and diversion ditches (1976).

On several occasions levees from the waste oil pits ruptured following heavy rainfalls. In 1967 Pit No. 7 ruptured spilling its contents onto adjacent private property and into McGirts Creek. The City of Jacksonville Mosquito Control Branch, recognizing the threat of other pits rupturing if the water level was not controlled, began to build a two cell oil/water separator in conjunction with a limestone filtering system in an attempt to dewater the pits. The City attempted to reinforce the ponds' retaining walls to prevent further pollution problems in 1967, 1972, and 1974. An attempt was made to have the Whitehouse site declared a mosquito control project, along with an adjacent swamp area since the swamp could not be properly drained without addressing the oil pits first. The request was denied by the Florida State Bureau of Entomology in 1974. In 1975 an attempt was made to obtain Florida State Department of Environmental Regulation pollution restoration funds to rectify and close out the problem area. This request was also denied.

To compound the situation, erosion caused by motorcycle and four-wheel drive vehicles weakened the retaining berms. On June 29, 1976, after abnormally heavy precipitation, the retaining berm of Pit No. 6 on the western edge of the site collapsed during some minor repair work by Mosquito Control Branch personnel. The resulting breach allowed approximately 757 m^3 (200,000 gal) of the captured waste oil material and an undetermined amount of highly acidic water to flow into McGirts Creek and the adjacent natural water collection basin. An oil spill emergency was declared and the U.S. Coast Guard, a private consulting firm, and the Bio-Environmental Services Division (BESD) of the Jacksonville Department of Health, Welfare, and Bio-Environmental Services were mobilized under the direction of the Oil Spills Group of the EPA Region IV Environmental Emergency Branch. Cleanup measures were initiated on the evening of June 29, 1976.

Waste oil remained in six pits until cleanup measures were completed on May 15, 1977. The wastes left in the pits contained high concentrations of PCB's, lead, and other metals, and had a pH of less than one. The lighter weight material, a black, oil-like fluid, floating on top had segregated in some areas into a thicker, yellow-colored greasy material. It contained 10 to 25 percent water and a 30 percent oil mixture consisting of 50 percent homogenized oil. Approximately 1 m (3 ft) of this material floated over a layer of water and bottom oil sludge. The top of the sludge was unstable becoming firmer with depth. Total thickness of the sludge was 2 to 3 m (6 to 10 ft). In 1974, there was an estimated 7,500 m^3 (1,982,000 gal) of oil, rainwater, and sludge in the pits.

REMEDIAL ACTION

First Phase

Initially the EPA and the Coast Guard had concentrated their efforts on cleaning up the spill and stabilizing the walls of the pits to prevent further collapse. However, it was recognized that the remaining six oil pits presented a potential for a similar or possibly larger spill unless corrective actions were taken. Therefore, EPA and Coast Guard officials authorized the use of federal Emergency Contingency Funds to (1) cleanup the existing oil spill, (2) repair the oil pit filter system originally built by the City of Jacksonville, and (3) provide material for the construction of access roads to each of the six remaining pits so that pump-out operations could proceed. Total cost for the above operations was estimated at $100,000.

After the EPA enacted the federal response to the oil spill, disposal became the next major obstacle. The spilled material was disposed in a proper manner in Duval County. To eliminate the imminent threat of another spill from the pits, alternative and more econcomical disposal sites were sought. The City proposed several sites but could not get approval from the State to use them. Because of the lack of a suitable disposal site or method, a ten day delay was encountered.

The delay allowed the agencies to become more familiar with the material in the pits. It was determined that the only feasible means of disposal was to reactivate the oil/water separator and filter system the City had employed during previous efforts. This would allow the pits to be dewatered and eliminate the threat of another major spill.

The City of Jacksonville suggested that after the pits were dewatered they would mix the remaining oil and sludge with dry trash and dirt and fill all the pits. Because of the emergency, State and City agencies agreed to the following at a July 6, 1976 conference:

1. On an emergency basis, Mosquito Control Branch equipment would be used to re-establish the filter beds and construct the necessary pit access roads.

2. The dewatered pits could be designated as a dry trash landfill. Material such as dry tree limbs, leaves, building materials, and any other absorbent materials would be employed to stabilize the sludge remaining at the bottom of the pits. These materials were to be selected loads of refuse from the City-operated

disposal sites. The absorbent materials would be deposited in the pits which had been emptied of the oil and oil emulsion and the materials graded and compacted by a crawler tractor. Upon completion of the filling and after consolidation of the debris, portions of the pit embankment walls would be graded over the pit to provide soil cover for surface drainage.

3. The necessity for a sanitary landfill application and operating permit would be waived. State Water Pollution Control personnel would monitor the leachate from the defluidized stabilized system and from time to time would report the need to haul away additional petroleum residues at the expense of the City.

The dewatering operation was one day from start-up when the EPA received word from the Coast Guard that there was a possibility the oil in the pit was contaminated with PCB's. Until then, the spill had been handled as a routine oil spill. This new information not only halted the entire operation, but required the chemical analysis of the material in the pits and surface and ground water monitoring.

After evaluating the data, three alternatives were considered by the EPA Regional Response Team for the ultimate disposal of the PCB contaminated waste oil:

1. The impounded material would not be treated on-site. Rather, all of the PCB contaminated waste oil would be placed in sealed containers and shipped to an approved facility. A conservative estimate of the amount of contaminated material was made and using a Rollins Environmental Services price sheet, it was calculated that approximately $7.5 million would be needed. This estimate did not include labor charges. It was obvious from the cost figures, together with the fact that federal funds were no longer available, that this was not a viable alternative.

2. The impounded material would be discharged without treatment and the remaining oil and sludge disposed at an approved facility. This alternative was finally rejected because the cost of hauling the semi-solid materials was still prohibitively high and data suggested that concentrations of PCB's exceeding 1 ppb could be expected in any water discharged to McGirts Creek. At that time, the EPA was recommending that manufacturers not exceed 1 ppb of PCB in any discharge.

3. The oil would be immobilized on-site and a water treatment system designed that would produce an effluent less than

1 ppb PCB. Since current technology was available for producing an effluent of 1 ppb using activated carbon, this appeared to be the best of the alternatives.

The task of immobilizing the oil was assigned to the City of Jacksonville in conjunction with the EPA Region IV Residual Management Branch and the Florida Department of Environmental Regulation. The remedial action selected included draining as much water as possible through a treatment system and stabilizing the remaining fluids. The treatment system was designed by the EPA and modified by City employees during construction to treat and dewater all the pits (the City Finance Committee approved $13,000 for the project). The system included (1) treatment of water which had been drained from the remaining oil pits to separate the oil and water; (2) two limestone filtering beds to neutralize acid and filter out oil, metals, and other contaminants; and (3) a carbon mixing and settling system to adsorb and remove PCB's. The treatment system was devised to be practical, inexpensive, easy to operate, and have the capability to reduce the PCB level below 1 ppb for all water discharged to McGirts Creek. The system was to be a temporary measure and only minimum maintenance would be required.

It was obvious from the initial discovery of PCB's in the pits that the only effective treatment of the water would be with activated carbon. Research and practice had shown that carbon adsorption was the best available field method for removing PCB's from wastewaters. Carbon adsorption systems in industrial applications could remove PCB's from wastewater effluents to concentrations less than 1 ppb; however, these systems all employed carbon adsorption columns and the carbon column was not the best method of treatment in this emergency situation for the following reasons:

1. Construction of the columns was considered too costly and time-consuming. Also, the columns would have required additional pumps.

2. Due to the limited laboratory facilities nearby and the inconsistent quality of the influent, it would have been difficult to determine when the carbon in the column had become saturated.

3. Replacement of carbon in column would be difficult. Moreover, the oily water would tend to coat the surface of the granular coarbon and reduce its adsorption effectiveness.

4. Granular activated carbon was twice as expensive as powdered carbon. Moreover, the nearest source was approximately 965 km (600 mi) from the spill site.

A system using powdered activated carbon for removing PCB's from water had never been employed in other than laboratory-scale experiments. These experiments all yielded treated effluent PCB levels well below the acceptable level of 1 ppb. With these results and previous experience in the use of activated carbon for removing organics from water, a treatment system was designed using powdered activated carbon. [10-2]

The carbon treatment system consisted of four units: (1) a collection sump, (2) a carbon mixing chamber, (3) a sedimentation basin, and (4) a sand filter (see Figure 10-4). A collection sump was used to collect water draining from the oil pits. When sufficient water was collected, the sump pump directed the liquid to the carbon mixing chamber at a rate of 227 l/min (60 gal/min). The carbon slurry was injected at a concentration adjusted to maintain an effluent concentration of less than 1 ppb of PCB in the waste. The chief goal of the sedimentation basin was to provide adequate detention time for gravity sedimentation of the carbon and absorbent contaminants. A final sand filter was provided to filter the effluent prior to discharge into McGirts Creek.

After dewatering, fuller's earth was mixed with the remaining oil and sludge to combine with the oily matter. Fuller's earth is a semi-pulverized clay which absorbs oil and water rapidly. Laboratory experiments had shown this mixture was stable and did not release oil or sludge even when submerged in water. Approximately 7,200 metric tons (8,000 tons) of fuller's earth was mixed in this manner.

To provide adequate control over the mixing operation, a batching pit was prepared just south of Pit No. 4. Pumpable material was taken out of the pits and placed into an 11 m^3 (3,000 gal) settling tank. Water obtained from the settling tank was drained to Pit No. 7 and passed through the treatment system. The remaining settleable material was mixed by heavy equipment in the batch pit and then placed in the oil pit which was being closed out.

The sludges remaining in the pit were stabilized by placing a layer of clean trash consisting of scrap lumber, trees, and wood chips to form a matrix which penetrated into and bridged over the viscous sludge in the pit bottom. The less viscous sludge was displaced by this material to a centralized location. The more viscous sludge remained in place and in time was absorbed and solidified under the pressure of the overburden. The minimum thickness of trash overburden was determined by the depth required to support heavy equipment and prevent swelling of the pit material.

Auto shredder waste, consisting primarily of upholstery and similar absorbent and highly compressible material, was

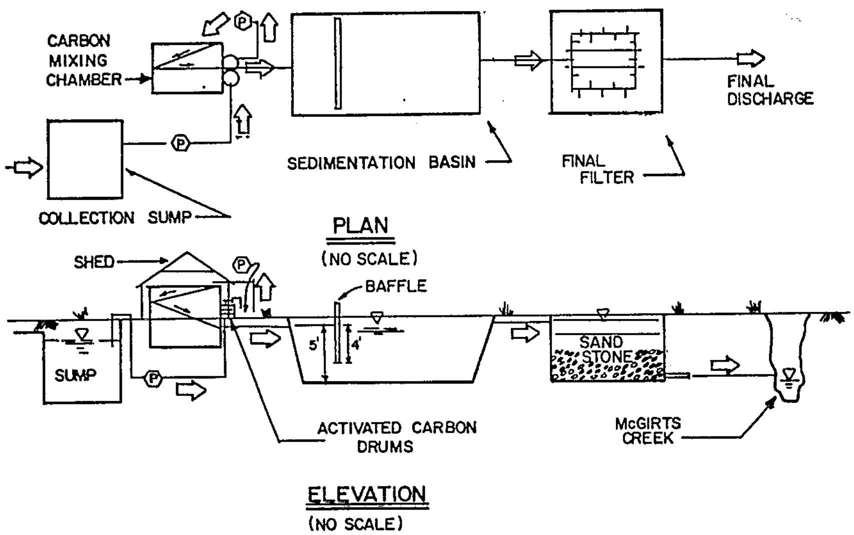


Figure 10-4. Carbon adsorption treatment plant for PCB's. [10-2]

placed above the clean trash for support. This sealed the surface voids in the trash and provided a base for the mixture of oil and fuller's earth placed in a layer above it. In this way, the fuller's earth mixture provided an impermeable blanket that kept rainwater from percolating downward. This was to eliminate the major driving force for ground water contamination migration and keep the viscous sludge and fugitive oil in a state more conducive to solidification over time. A final layer of clean fill dirt was placed above the clay blanket and graded to take maximum advantage of the natural slope of the site for drainage (see Figure 10-5).

After treatment of water and sludge had been accomplished and the pits filled and packed, several drainage ditches were constructed around the former pits to help divert runoff through the limestone filters and to intercept ground water entering the site and leachate leaving the site. The basic plan was to take maximum advantage of the site topography to isolate the pits hydraulically from the surrounding ground water. This process was completed on May 15, 1977.

<u>Second Phase</u>

Because stabilization efforts were not permanent or completely effective, a permanently stabilized area became necessary to eliminate the seepage of contaminated material. On June 30, 1980 the City of Jacksonville agreed to assume responsibility to accomplish the following tasks:

1. Covering the entire site with soil.

2. Vegetating the cover material.

3. Rerouting surface drainage.

4. Erecting a fence to restrict public access.

First, the entire site was covered with 46 cm (18 in.) of soil purchased under City contract. The first 15 cm (6 in.) of the material consisted of tight clay and the top 30 cm (12 in.) was borrow fill dirt (primarily sand). The cover material serves several purposes. It provides a thick uncontaminated zone to permit a good growth of grasses. Cover material was also used to level out the irregular surface settling that had occurred. By establishing a good drainage gradient and a continuous clay blanket across the site surface, downward percolation of rainwater has been minimized. Grasses help to remove surface water through evapotranspiration. This in turn has reduced the hydraulic gradient on the contaminated material and the forces tending to cause it to migrate through the berms and off site.

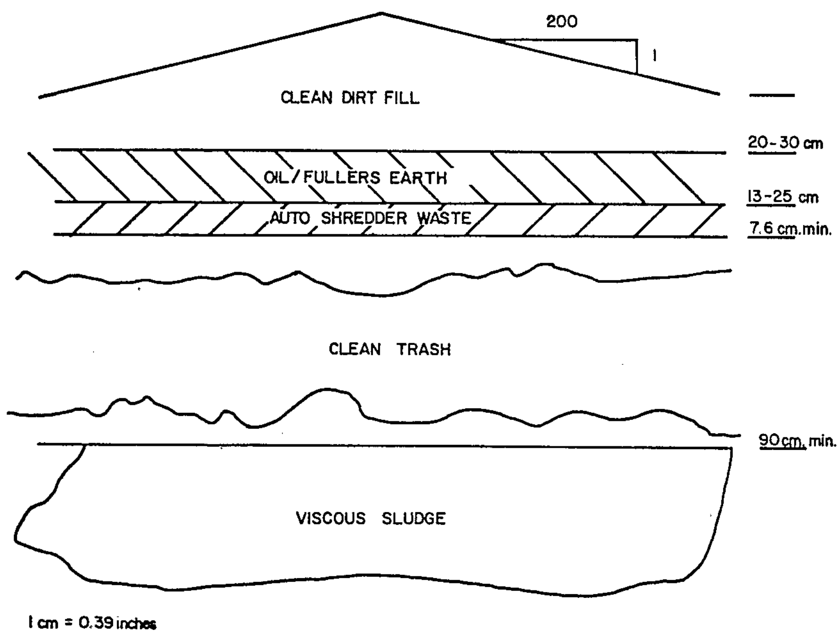


Figure 10-5. Pit profile after stabilization. [10-2]

A major effort of this project was to reroute drainage on the north edge of the pits. The new ditch has routed drainage around the contaminated area, thus eliminating the opportunity for rainfall to carry contaminants from the site. At the same time the new ditch was being excavated, the old ditches were filled with clay materials to prevent lateral movement away from the site. An attempt was made to scrape all the contaminated material out of this area and place it atop the pits for proper burial prior to filling the old ditches.

Extensive vandalism has occurred in the past at the site. Cars, four-wheel drive vehicles, and motorcycles have used the area, allowing little vegetation to grow. Because of the importance of establishing and maintaining adequate ground cover, a fence may be installed. The fence and signs would serve as a serious warning to the public of the hazardous nature of some of the material buried there and of the desire to restrict access as a public safety measure. If an attempt is not made to restrict site access, much of the improvement associated with the proposed project could be lost over a fairly short time.

The total cost to the City of Jacksonville and the EPA for the first phase of remedial action (between June 29, 1976 and May 15, 1977) was estimated at $250,000. A partial accounting for these costs is shown in Table 10-1. It should be noted that most of this cost was borne by the City of Jacksonville. In addition, a cost of $67,191 was projected for the second phase of remedial action beginning in July 1980 as shown in Table 10-2.

MONITORING

As a result of the PCB contamination, a full scale sampling and analysis program was initiated in which samples of the creek, ground water, raw water (in the pits), sludge, and well water (from nearby homes) were taken and analyzed for PCB's, heavy metals, phenols, and pH. An initial monitoring effort on July 13, 1976 consisted of the BESD analyzing samples from four private water supply wells in the vicinity of the Whitehouse site for possible contamination (see Figure 10-2 and Table 10-3). The results of the analyses are contained in Table 10-4 and indicate that the water quality in these wells was not affected by the oil pits. The iron and phenol contents of two of the wells were considered slightly high; however, the iron content is not unusual for shallow wells in Duval County, and the phenol content was not so high as to require closing of the water supply for drinking water purposes. Surface water samples were also obtained from the limestone filtering system and McGirts Creek, and analyses revealed no PCB's were present.

At the request of EPA, a sampling team from the EPA Athens Laboratory was dispatched to the Whitehouse site on July 20, 1976. Samples were obtained on July 21, 1976 from the sidewalls of

TABLE 10-1. PARTIAL REMEDIAL ACTION COSTS FOR FIRST PHASE

Cost Item	Date: 6/29/76 thru 7/9/76	Date: 8/04/76 thru 9/30/76	Date: 10/1/76 thru 2/01/77	Total
Vehicles/Equipment/Personnel	$34,325	$17,417	$36,118	$ 87,860
Supplies, Fullers Earth, Etc.	--	27,688	2,691	30,379
Services and Charges	--	485	--	485
Capital Outlay	3,433	4,657	--	8,090
Mosquito Control Costs	--	17,902	40,745	58,647
Total	$37,758	$68,149	$79,554	$185,462

TABLE 10-2. PROJECTED REMEDIAL ACTION COSTS FOR SECOND PHASE

Item	Cost
Cover Material (sand and clay borrow fill dirt)	$33,848
Equipment Use (lease Mosquito Control Gradal and operator plus borrowed front-end loader)	4,000
Site Vegetation	12,620
Night Security	1,048
Port-O-Let Rental	85
Fencing or Other Access Restricting Means	11,600
Clearing and Grubbing	290
Miscellaneous Equipment, Supplies and Materials	3,700
Total	$67,191

TABLE 10-3. DEPTH OF MONITORING AND PRIVATE WELLS

Well Number	Depth (m)
EPA #1	21-24
EPA #2	15-18
EPA #3	6-9
U.S.G.S.#1	5-6
U.S.G.S.#2	5-6
U.S.G.S.#3	5-6
158 Machelle Drive	Unknown
233 Machelle Drive	41
258 Machelle Drive	Unknown
263 Machelle Drive	Unknown

1 m = 3.3 ft

TABLE 10-4. WATER QUALITY IN WELLS*

Well Number	Date	pH	Fe	PCB	Oil & Grease	COD	Phenols	Zn	Pb	Cd	Cu	Cr
EPA #1	5/20/77	7.05	0.54	None	1.8	<10	0.002	0.009	0.17	0.17	<0.04	<0.1
	7/18/77	7.35	0.74	None	4.3	45.6	0.13	0.09	0.55	0.02	0.10	<0.1
	1/3/79	6.80	0.28	--	3.6	--	--	0.014	<0.03	<0.005	<0.004	<0.01
	5/23/79	--	1.19	<0.0002	0.007	--	0.019	0.012	<0.25	<0.025	0.147	<0.02
EPA #2	5/20/77	6.90	3.89	None	1.7	52	0.005	0.009	0.08	0.19	<0.04	<0.1
	7/18/77	7.30	0.54	None	9.4	56.1	0.001	0.31	0.6	0.02	0.26	
	1/3/79	6.70	0.23	--	4.5	--	--	0.003	<0.03	<0.005	<0.004	<0.01
	5/23/79	--	0.42	<0.0002	0.003	--	0.015	0.03	<0.25	<0.025	0.152	<0.002
EPA #3	5/20/77	3.85	114.4	None	1.3	22	0.003	0.04	0.28	0.11	<0.04	<0.1
	7/18/77	3.80	12.6	None	4.4	119	0.001	0.02	0.78	0.04	<0.05	
	1/3/79	3.45	212	--	4.1	--	--	3.6	0.36	0.05	0.03	<0.01
	5/23/79	--	198	<0.0002	0.0042	--	0.021	0.035	<0.25	<0.025	0.147	<0.02
USGS #1	5/20/77	5.75	9.12	None	1.4	52	0.02	0.02	0.34	<0.02	<0.04	<0.1
	7/18/77	5.85	0.114	None	5.2	175	0.002	<0.01	0.75	0.02	<0.05	
	1/3/79	5.50	7.8	--	1.9	--	--	0.11	0.25	0.03	0.004	<0.01
	5/23/79	--	1.19	<0.0002	0.007	--	0.019	0.012	<0.25	<0.025	0.147	<0.02
USGS #2	5/20/77	3.55	27.02	None	0.04	648	<0.04	2.10	0.17	0.09	<0.04	<0.1
	7/18/77	3.55	0.23	None	5.4	1901	1	0.03	0.60	0.02	0.56	
	1/3/79	3.55	29.8	--	5.5	--	--	0.30	0.10	0.02	0.004	<0.01
	5/23/79	--	41.2	<0.0002	3.0	--	0.90	0.096	<0.25	<0.025	0.107	0.02
USGS #3	5/20/77	5.00	0.75	None	0.02	120	0.004	0.009	0.08	0.02	<0.09	<0.1
	7/18/77	4.95	0.03	None	6	56.1	0.004	<0.01	0.60	0.02	<0.05	
	1/3/79	4.70	0.51	--	2.5	--	--	<0.003	<0.03	<0.005	0.03	<0.01
	5/23/79	--	0.383	<0.0002	0.004	--	0.016	0.062	<0.25	<0.025	0.19	<0.02
158 Machelle Dr.	7/13/76	7.4	0	--	--	--	0.001	0.42	0.008	--	--	0
	1/3/79	--	--	--	--	--	--	--	--	--	--	--
233 Machelle Dr.	7/13/76	7.1	0.6	--	--	--	0	0.42	0.002	--	--	0
	1/3/79	--	--	--	--	--	--	--	--	--	--	--
258 Machelle Dr.	7/13/76	7.2	0.7	--	--	--	0.002	0.32	0.001	--	--	0
	1/3/79	7.85	0.18	--	--	--	<0.0005	0.096	<0.031	<0.005	<0.004	<0.011
263 Machelle Dr.	7/13/76	7.1	0.6	--	--	--	0.002	0	0	--	--	0
	1/3/79	7.05	1.9	--	--	--	<0.0005	0.262	<0.031	<0.005	0.082	<0.011

-- Not Analyzed.
* All concentrations shown in ppm.

the pits. No bottom sludge samples were obtained due to the unknown depth and the hazards involved in reaching the center of the pits. The analyses indicated that PCB's were present in the sludge of five of the six oil pits in concentrations ranging from 8.7 ppm to 23.3 ppm. Because PCB's are soluble in an oil-water mixture at low pH, it was anticipated that PCB's were being discharged from the pits. Complete analytical results are listed in Tables 10-5 and 10-6. Quantitative tests for copper, lead, zinc, cadmium, and chromium, as expected, appeared in insignificant quantities. These are typical metals found in the waste oil process so these results were not surprising.

The EPA Surveillance and Analysis Division (S&A), due to manpower shortages, was only able to lend limited sampling and analysis support after the initial oil sludge samples were handled. Treatment system samples were split between S&A and the BESD. This procedure produced a lengthy "turn-around time" for actual results. In order to obtain a more rapid indication of PCB removal, the BESD was requested to run chemical oxygen demand (COD) tests. Organic contaminants are expected in any oily waste and these contaminants will tend to occupy adsorption sites on the carbon filter along with the PCB's. Hence, COD tests will indicate an increase or decrease in the effectiveness of removal of all the organics (both toxic and non-toxic) by the carbon. A correlation exists between removal of organics and PCB reduction, therefore, lower COD values indicate lower PCB concentrations. Also, the COD tests were less expensive and a more rapid indicator of PCB removal efficiency than direct PCB analysis.

The initial discharge on September 20, 1976 was analyzed for PCB's and COD. Samples were taken from the water as it entered Pit No. 7 and from the effluent as it entered McGirts Creek. Then the treatment process was discontinued until treatment efficiency results were obtained. These results indicated that the PCB concentration was below 1 ppb in the effluent and that the carbon feed was initially correct. Using the COD test as an indicator, the PCB concentration was kept consistently below 1ppb in the effluent. Samples were obtained once each day that the system had been running. Some results of effluent monitoring are shown in Table 10-7. It should be noted that the carbon mixing proportions were continually adjusted based upon laboratory analysis with the goal of keeping PCB levels in the effluent well below 1 ppb.

Another problem considered was that of migration of PCB's to the ground water table. To assist in determining the extent of migration from the pits, the EPA Region IV Residual Management Branch contracted a consultant to perform a ground water study of the Whitehouse site. The objective of the study was to ascertain whether or not migration of hazardous wastes had occurred in

TABLE 10-5. INITIAL PCB ANALYSIS OF SLUDGE SAMPLES

Location	PCB Concentrations (ppm) PCB Aroclor 1242	PCB Aroclor 1254	PCB Aroclor 1260	PCB Total (ppm)
Pit No. 1	6.0	2.8	5.6	14.4
Pit No. 2	10.0	3.5	9.7	23.2
Pit No. 3	ND	ND	ND	--
Pit No. 4	9.3	4.3	7.6	21.2
Pit No. 5	6.9	3.7	6.5	17.1
Pit No. 6	3.3	2.3	3.1	8.7

ND = Not detectable

TABLE 10-6. QUANTITATIVE ANALYSIS OF OIL SLUDGE

Sample Number	Total Metals From Ashed Sludge - Wet Weight of Sludge (ug/g) Lead	Copper	Zinc	Cadmium	Chromium
2	2,800	25	56.5	0.6	7.5
3	5,300	37	43	0.5	11
4	1,830	15	17	0.3	4
5	1,320	8	6	0.2	8
6	2,640	31	24	0.3	9
7	7,060	62.5	56	0.8	12

Qualitative Scan of Oil Sludge
Elements Detected in Sample From Pit 2

Lead	Rubidium	Vanadium
Cerium	Bromine	Titanium
Lanthanum	Selenium	Scandium
Barium	Arsenic	Calcium
Antimony	Gallium	Potassium
Tin	Zinc	Chlorine
Cadmium	Copper	Sulfur
Silver	Nickel	Phosphorous
Ruthenium	Cobalt	Silicon
Molybdenum	Iron	Aluminum
Zirconium	Manganese	Magnesium
Strontium	Chromium	Fluorine

TABLE 10-7. ANALYSES OF TREATMENT SYSTEM REMOVAL EFFICIENCIES

Date	Influent PCB (ppb)	Influent COD (ppm)	Influent Carbon (ppm)	Effluent PCB (ppm)	Effluent COD (ppm)	Percent PCB Removal
9/20/76	--	369	27.0	<0.2	66	--
9/25/76	0.73	--	10.7	ND	399	--
9/26/76	0.56	1,068	10.7	ND	282	--
9/28/76	2.22	--	10.2	0.26	--	88
9/29/76	7.7	988	10.2	0.4	419	95
9/30/76	0.93	932	28.6	0.99	394	--
10/1/76	1.49	942	28.6	0.29	463	81
10/6/76	1.15	1,068	25.9	0.14	399	88
10/7/76	0.66	1,000	43.5	<0.2	571	70
10/8/76	0.62	1,225	43.5	<0.2	372	68

ND = not detectable.

the ground water adjacent to the waste oil pits (see Figure 10-3). In September 1976, three piezometers were placed to depths of 10, 18, and 24 m (30, 60, and 80 ft) (see Appendix 10-1 for well log) and were developed using compressed air. After pumping each well at a rate of about 0.3 l/sec (5 gal/min) until clear water was obtained, water samples were obtained for chemical analyses. Water quality analyses on the three wells indicate that ground water contamination may have occurred to a depth of at least 24 m (80 ft) beneath the oil pits. The results of the three samples from the EPA wells are summarized in Table 10-4.

Under a cooperative program between the City of Jacksonville and the U.S. Geological Survey (U.S.G.S.), three additional wells were installed around the site perimeter in early 1977. These wells along with the wells drilled by the consultant contracted by the EPA were monitored periodically.

In 1979 an increase in leachate from the site was noticed in the perimeter ditches which surround the site. This leachate had a slight oil sheen and odd odor. Biological and chemical sampling upstream and downstream from the site indicated that the leachate was having a detrimental effect on the quality of the water.

To determine the effect of the leachate from the site on the biota of McGirts Creek, macro-invertebrate samples were taken by the Florida Department of Environmental Regulation (DER) on October 11, 1979 and December 6, 1979. During the October sampling, 33 types of organisms were found present in a tributary upstream. Each time a sample net ran through the substrate it was teeming with organisms. The bottom was a mixture of aquatic grasses, sand, and detritus. The tributary had all the indications of a healthy aquatic environment. Downstream from the site, only four types of organisms and a total of eight organisms had been found after two and one-half hours. No vegetation was present in the water. The only growth on the bottom was described as a "sewage slime". Chemical analysis of water samples revealed toxic levels of heavy metals, traces of PCB's, and extremely low pH.

CONCLUSION

When the retaining berm of the waste oil pit collapsed contaminating McGirts Creek with the highly acidic oil and sludge in 1976, EPA and the City of Jacksonville took actions to correct the problem. Within one year, the waste either had been removed, treated, or stabilized within the pits.

The main problem facing the project since the first cleanup efforts began in 1967 was the financial constraints within which it had to operate. If City crews had been given the proper funds in 1974 and 1975 and allowed to complete the dewatering operation, the oil spill in 1976 could have been averted. However, the possibility of future spills would have remained unless the waste oil and sludge (the ultimate source of pollution) were part of the cleanup program. Therefore, the 1976 spill did bring the seriousness of the problem to the attention of the EPA and City officials, resulting in a comprehensive effort to mitigate the problem.

The carbon filter was successful. PCB concentrations in the effluent were maintained below 1 ppb. However, short term analysis of the stabilization efforts indicates that the oil sludge has not been totally stabilized. Numerous leachate outcroppings have been noted along the eastern and western margins of the site. In addition, the sampling of McGirts Creek in 1979 and 1980 has shown a severe disruption of the local biota downstream from the Whitehouse site. Evidence indicates toxic leachate is leaving the site and migrating into McGirts Creek. Some of the possibilities for the above problems include the following: (1) the decomposition of the truck and auto shreddings from the acid sludge, (2) an insufficient value of absorbent material added to the acid sludge and oil, (3) high ground water levels, and/or (4) the absence of a site covering to prevent rainwater infiltration.

The second phase of remedial action which began in 1980 may alleviate many of the problems. A new ditch has been constructed up-gradient from the site and several existing ditches are being filled with clay material. The effect should be to lower the ground water table and to divert ground and surface water around the site. The clay cover should considerably reduce the seepage of toxic wastes into the ground water.

Even though the second phase should considerably reduce the pollutants in the ground water and McGirts Creek, chances are that some problems will continue at the site and more money will be required to permanently stabilize and/or isolate the wastes to protect the surface and ground water of the area. Frequent monitoring will be required to ensure future problems do not develop.

SITE I REFERENCES AND BIBLIOGRAPHY

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10-3 Personal communication with Jan B. Rogers, Raymond T. Wilkerson, and Fred B. Stroud, Environmental Emergency Branch, Region IV, U.S. Environmental Protection Agency. Atlanta, Georgia. July 23, 1980.

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APPENDIX 10-1

WELL LOG FOR SITE I

WELL LOG AT WHITEHOUSE OIL PITS

Description	Depth (m)
Black silty sand, with trace of clay (fill)	0-2
Very fine to fine dark gray sand, oily matrix, with traces of silt and clay	2-5
Very fine to fine, dark brown sand, with traces of silt and clay	5-7
Very fine to fine, dark brown to black sand, some cementation, with trace of silt	7-8
Very fine to fine, reddish brown sand	8-9
Very fine, olive green sand, with traces of silt	9-12
Very fine, silty, light gray sand	12-14
Very fine, greenish-gray sand	14-16
Very fine, light gray sand, with traces of silt and clay	16-22
Very fine green sand with light to medium gray shell fragments interbedded with clay and silt	22-26
Silty green clay with traces of shells and very fine sand, with one thin bed of weathered coquina at 34 to 35 m of depth	26-37

1 m = 3.3 ft

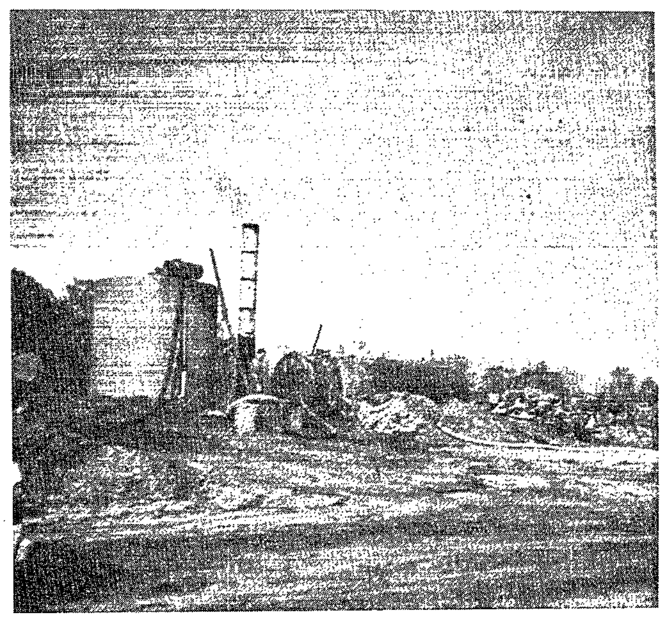
APPENDIX 10-2

SITE I PHOTOGRAPHS

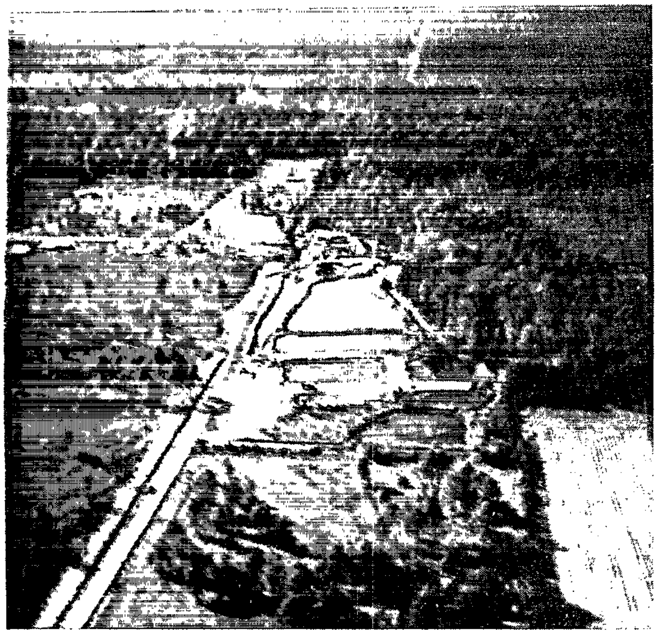
The Whitehouse site in July 1980.

Outcrop of oil sludge (July 1980).

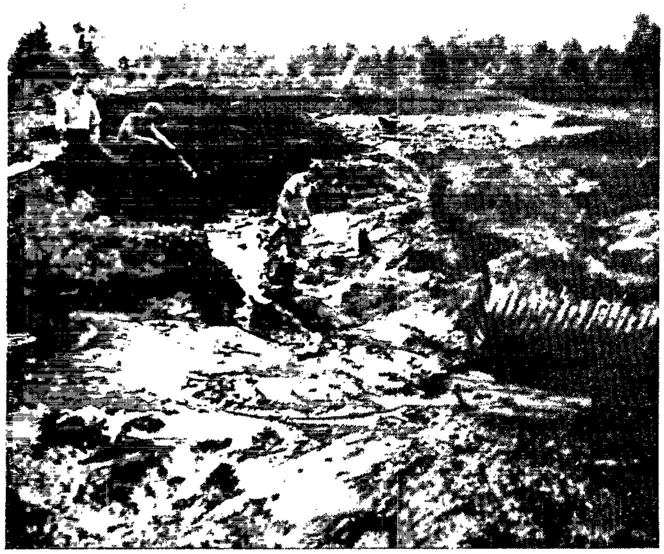
Oil pit being filled with refuse (1976).



Oil storage tanks and fuller's earth mixing operations (1976).



Aerial photograph of the Whitehouse oil pits (1976).



Oil flowing to McGirts Creek from
ruptured pit (1976)

*U.S. GOVERNMENT PRINTING OFFICE: 1981-0-720-016/5987