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Superfund Record of Decision:

Fultz Landfill, OH

50272-101

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

The 30-acre Fultz Landfill site is a privately owned inactive sanitary landfill on the north slope of a ridge that overlies abandoned coal mines in Jackson Township, Guernsey County, Ohio. Land use in the vicinity of the site is primarily rural to the south, north, and east; and residential and light industrial to the west. The site lies within the drainage basin of Wills Creek, which flows north adjacent to the site and is used by the city of Cambridge as the municipal water supply. The northern half of the landfill lies in an unreclaimed strip mine where surface mine spoil and natural soil form a shallow aquifer. The southern half of the landfill lies 25 to 80 feet above an abandoned flooded underground mine in the same coal seam as the strip mine. The flooded underground mine forms an aquifer, which also is utilized for drinking water. Six ponds, designated as wetlands, are located on the north side of the landfill in the area of unreclaimed strip mine spoil. Surface water runoff and leachate from the landfill collect in several of these ponds. From 1958 to 1968, the landfill was operated as an open dump. In 1969, the site was licensed by the County and began to accept household, commercial, and industrial solid waste. During the 1970's, the landfill operator was cited for various

(See Attached Page)

17. Document Analysis a. Descriptors

Record of Decision - Fultz Landfill, OH
First Remedial Action - Final
Contaminated Media: soil, sediment, debris, gw, sw
Key Contaminants: VOCs (benzene, PCE, TCE, toluene, xylenes), other organics (PAHs, phenols), metals (arsenic, chromium, lead), other inorganics

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 106
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Abstract (Continued)

violations including inadequate daily cover of waste, receiving unauthorized waste, leachate runoff, blowing debris, and open dumping; and in 1985, onsite landfill operations ceased. Disposal records show that an estimated 6,240 drums containing chlorinated and non-chlorinated solvents and plating sludge were disposed of in the landfill. Records also show that drummed liquid and semi-liquid wastes were disposed of onsite, and some of the solvents were poured directly onto the ground and burned. Investigations in 1988 by EPA indicated that ground water and leachate contaminants emanating from the site have contaminated the shallow aquifer and, to a lesser extent, the deep mine aquifer. This Record of Decision (ROD) addresses all contaminated media, and provides a final remedy for the site. The primary contaminants of concern affecting the soil, sediment, debris, ground water, and surface water are VOCs including benzene, PCE, TCE, toluene, and xylenes; other organics including PAHs and phenols; metals including arsenic, chromium, and lead; and other inorganics.

The selected remedial action for this site includes constructing a containment berm and capping the entire 30 acres of the landfill with a multi-layer cap; installing structural supports for voids in the underground mine to prevent cap damage by subsidence; constructing an onsite treatment plant and leachate collection system; pumping and onsite treatment of contaminated ground water and leachate using oxidation and precipitation to remove metals, and filtration and carbon adsorption to remove organics, or using another treatment based on the outcome of a bench-scale treatability study; discharging the treated effluent onsite to surface water; regenerating spent carbon or disposing of the carbon offsite; disposing of sludge resulting from the treatment plant processes offsite; constructing surface water and sediment controls to divert runoff away from the landfill; mitigating affected wetlands; providing an alternate water supply for contaminated residential wells by connecting these homes to a municipal water supply; monitoring soil, sediment, ground water, and air; and implementing institutional controls including deed restrictions to limit ground water and land use, and site access restrictions including fencing. The estimated present worth cost for this remedial action is $19,480,700, which includes an annual O&M cost of $218,000 for 30 years.

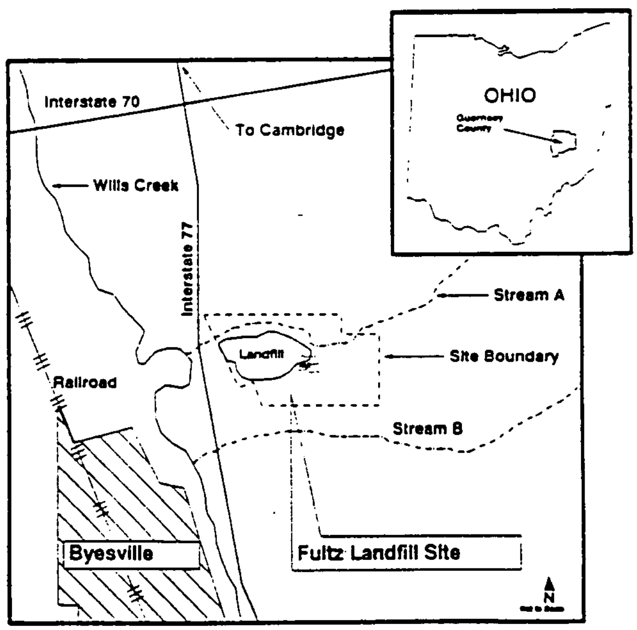
PERFORMANCE STANDARDS OR GOALS: For ground water remediation, site-related contaminants that appear upgradient will be reduced to their respective background concentrations. Other non-background contaminants will be reduced to SDWA MCLs, or to a cumulative carcinogenic risk no greater than 10^{-6} or an HI<1. Discharge of treated leachate and ground water must meet CWA and State requirements. Chemical-specific remediation goals were not provided.

U.S. ENVIRONMENTAL PROTECTION AGENCY

Record of Decision

Fultz Landfill

Byesville, Ohio



Declaration for the Record of Decision

Site Name and Location

Fultz Landfill
Byesville, Ohio

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Fultz Landfill site, in Byesville, Ohio, which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision document explains the factual and legal basis for selecting the remedy for this site. This decision document is based on the administrative record for this site.

The Ohio Environmental Protection Agency (OEPA) concurs with the selected remedy. The information supporting this remedial action decision is contained in the administrative record for this site.

Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Selected Remedy

The selected remedial action for the Fultz Landfill site addresses the source of contamination by containing the landfill contents and treating contaminated groundwater and leachate. This is the first and final remedy for the Fultz Landfill site. The major components of the selected remedial action include:

- Institutional controls will be sought to reduce exposure to site contaminants through legal restrictions. In the event that institutional controls are not implemented, the selected remedial action will be re-evaluated to determine if additional actions should be implemented to ensure that the remedy is permanent and effective on a long term basis.

- Site fence approximately 10,000 feet in length, to reduce direct exposure to surface contamination.

- Alternate water supply for downgradient residential wells if found to present an unacceptable risk, attributed to the site.

- Long term monitoring of air, surface and ground water, leachate, and sediments.

- Subsurface structural supports for mine voids, to prevent cap damage by subsidence, and reduce bedrock fracturing between the landfill and coal mine aquifer.

- Surface water and sediment controls to eliminate standing water and divert runoff away from the landfill.

- Berm and multi-layer cap to reduce infiltration, prevent erosion, and reduce human and environmental health risks from direct contact with contaminated materials.

- Leachate collection system to reduce the principal risk by removing leachate, which is currently flowing from the landfill at approximately 2 gallons per minute (GPM).
- Extraction well system to reduce the principal risk by intercepting contaminated groundwater migrating from the landfill through the shallow aquifer and into the coal mine aquifer.
- On-site water treatment system to economically treat six million gallons of contaminated groundwater which is currently being produced annually, and leachate. It will be most cost effective to treat leachate in the same system used to treat groundwater, rather than haul it off-site.
- Discharge of treated water to surface water will be in accordance with substantive requirements of a National Pollutant Discharge Elimination System (NPDES) permit.
- Wetlands replacement plan which will restore the ponds and surrounding habitat disturbed during remedial action activities.

Declaration of Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. This remedy utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and it satisfies the statutory preference for remedies that employ treatment that reduce toxicity, mobility, or volume as their principal element.

Because this remedy will result in hazardous substances remaining on site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Valdas V. Adamkus
Regional Administrator

9/30/91
Date

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Decision Summary for the Record of Decision
Fultz Landfill Site, Byesville, Ohio

I. Site Name, Location, and Description

The Fultz Landfill is located in an agricultural and coal mining region of east-central Ohio, approximately 75 miles east of Columbus, and is situated in Jackson Township in the northwest corner of Military Lot 5, Township 1 North, Range 3 West in Guernsey County, Ohio. The site is about one-half mile northeast of the corporate limits of Byesville, Ohio, and about one mile southeast of the interchange of Interstates 77 and 70, as illustrated on Figure 1. The county's largest city, Cambridge, lies approximately three miles northwest of the site.

The Fultz Landfill is a privately-owned sanitary landfill where hazardous industrial wastes were co-disposed with municipal waste. Closed since 1985, the landfill was one of two facilities that served the refuse-disposal needs of Guernsey County. The landfill, illustrated on Figure 2, occupies approximately 30 acres of a 58-acre land tract within Parcel 1 of Military Lot 5. Parcel 1, prior to 1950, was part of a large farm that comprised approximately 200 acres. Land use in the vicinity of the site is primarily wooded and pasture to the south, north and east. To the west, land has been developed for residential and light industrial use.

The landfill is situated on the north slope of a ridge that overlies a coal mine in the Upper Freeport Coal seam, which was abandoned prior to 1940. The north half of the landfill lies in an unreclaimed strip mine in the Upper Freeport coal seam, where surface mine spoil and natural soils form the "shallow aquifer." The south half of the landfill lies 25 to 80 feet above an abandoned, flooded deep mine in the same coal seam. The flooded deep mine forms an aquifer referred to as the "coal mine aquifer". The City of Byesville utilizes water from the coal mine aquifer at a location approximately one mile south of the site. The position of the landfill relative to the deep mine and the Byesville Plant Number 2 well is presented on Figure 3, which was produced from the available mine maps and illustrates the intricate pattern of room and pillar voids in the deep mine.

The site is located on the western edge of the Allegheny Plateau Physiographic Province, which was originally a low-lying plain of sedimentary rock that has since undergone uplift and erosion. Topographic relief in Guernsey County varies by approximately 200 feet. Surface elevations at the Fultz Landfill site vary from approximately 800 to 900 feet MSL. A high percentage of the land surface in the vicinity of the site is steeply sloping, with natural slopes of 10% to 25% occurring on and near the site. Broad flat areas are found along the Wills Creek flood plain to the west of the site.

The site is located within the Wills Creek drainage basin, a subdivision of the Muskingum River basin. The total area drained by Wills Creek is approximately 850 square miles. Wills Creek flows northward adjacent to the site and through the City of Cambridge, which uses the creek as a municipal water supply, approximately three miles downstream.

The drainage course on the north side of the landfill is designated "Stream A." Prior to the existence of the landfill, Stream A was interrupted by surface mining activities, and six ponds were left in unreclaimed mine spoil. These ponds are numbered 1 through 6 on Figure 2. Pond 1 forms pond 1 and pond 1A during low precipitation periods. Pond 2 also becomes divided into pond 2 and pond 2A during low precipitation periods. The six ponds have been classified as wetlands by the U.S. Army Corps of Engineers. Surface water and leachate running off the landfill collects in ponds 1, 2, 3 and 6, which border the north side of the landfill.

The stream located south of the site is designated "Stream B," which drains a one-square-mile area consisting of farm land and reclaimed strip mines. Stream B discharges into Wills Creek upstream from the Stream A confluence.

The hydrogeology of the site area is complex due to the underground and surface coal mining. The groundwater regime generally consists of two hydrogeologic systems. The first, designated as the shallow aquifer system, consists of groundwater at water table conditions within the unconsolidated alluvial deposits and surface mine spoil in the Stream A and Stream B valleys. The second system is the partially-confined "deep mine aquifer" that formed from the flooding of interconnected abandoned underground coal mines of the Upper Freeport Coal. The coal mine aquifer is used by the City of Byesville as a source of municipal water, with the withdrawal point shown on Figure 3.

The population of Guernsey county was estimated at 40,280 in 1988. The Ohio Department of Development projects a county population of 52,606 by the year 2000. The major population centers for the area are Cambridge, which is the major center with an estimated 1988 population of 12,200 and Byesville with 2,690. The projected growth will result in an increased demand on the current water supply and will require the development of new areas for residential dwelling.

II. Site History and Enforcement Activities

The 30-acre landfill property was owned, developed and operated by Mr. Foster Fultz from October 1954 until his death in June 1982. The landfill was operated from 1982 until closing in 1985, by Mr. Fultz's family. The Fultz-operated landfill was an open dump from about 1958 through 1968. The site was first licensed by Guernsey County District Board of Health in 1969, at which time the landfill was permitted to accept household, commercial and industrial solid waste.

During the 1970's the operator was cited for inadequate daily cover of waste, open dumping, receiving unauthorized waste, leachate runoff and blowing debris. On April 14, 1983, the site was again brought to the attention of the authorities when a bulldozer working there rolled over a drum containing calsibar (a dry pyroforic powder mixture of calcium, silicon and barium). The calsibar ignited and burned. It was reported to local and state authorities that the calsibar drum was accidentally discharged to the landfill. The landfill ceased waste disposal operations in December 1985, when the owner failed to renew the operating permit for 1986.

The following is a summary of agency actions compiled from information provided by United States Environmental Protection Agency (USEPA), Region V, Ohio Environmental Protection Agency (OEPA) and the Guernsey County General Health District.

October 1968	Pre-licensing site survey by the Ohio Department of Health (ODH). Survey noted that the site could be unsuitable for a landfill because of proximity of the deep mine used by Byesville for a water supply.
February 1969	Fultz Landfill received an operating license from the County Board of Health.
March 1969	Operator (Fultz) submitted the required Operational Procedure Plan.
December 1969 through 1979	Operator repeatedly cited by the OEPA for inadequate covering of waste, open dumping, leachate runoff and receiving unauthorized industrial waste.

April 1978	An OEPA inspector reported seeing 1,000 drums on site. Final disposition of drums unknown.
May 1978	OEPA sent notifications to the known industrial clients of the landfill informing them of potential liability under Resource Conservation and Recovery Act (RCRA) for disposal of potential hazardous waste at an unauthorized facility.
1979	Operator informally requested OEPA permission to accept industrial solvents for disposal. Formal application never submitted, and request was denied.
March 1979	Operator submitted an operational report to OEPA.
1980	OEPA conducted sampling inspection of site. Results showed high levels of 10 metals plus phenolic compounds in leachate.
1981	Operator filed a request for solid waste disposal site investigation as part of a request to expand the boundaries of the landfill.
Early 1982	Request to expand landfill boundaries denied.
July 1982	Hazard Ranking System evaluation prepared by Field Investigation Team. Score exceeds 28.5 limit.
April 1983	USEPA performed a Responsible Party Search (RPS) to determine possible generators at the site.
June 1983	OEPA sent requests for information regarding the Fultz Landfill, to known industrial clients of the landfill, asking for records and information regarding waste disposal at the site.
April 1984	Final Remedial Action Master Plan was prepared by Consultants for USEPA, Region V.
September 1984	Consultants received a USEPA work assignment to perform a Remedial Investigation (Phase I).
February 1985	OEPA submitted a preliminary assessment of the site to the USEPA Region V.
1985	OEPA renewed operator's operational license.
1986	Operator did not apply for license renewal and ceased operations.
March 1988	Draft and Final Remedial Investigation (RI) Report, (Phase I), was prepared by Consultants for the USEPA, Region V. Data from Phase I RI was incorporated into the Phase II RI report.
March 1989	Consultants received a USEPA work assignment to perform a Remedial Investigation (Phase II), and Feasibility Study (FS).
June 1991	Draft and Final (Phase II) RI/FS Report are finalized and released by the USEPA.

June 27, 1991	Proposed Plan for remediation of site is presented to public. Public comment period begins.
July 11, 1991	Public meeting is held in Byesville, Ohio to explain and discuss Proposed Plan.
July 27, 1991	Public comment period ends.

The OEPA and County Board of Health records indicate that the landfill accepted about four drums per week of spent lacquer thinners from a local industrial plant as early as December of 1969. Based on the conservative assumption that two industrial waste generators shipped four drums each of hazardous waste per week for 10 years, it is estimated that 6,240 drums of hazardous waste may have been accepted and disposed of at the Fultz Landfill site. Although limited information is available concerning the character or volume of the wastes, information obtained during the Phase I RI indicates that chlorinated and non-chlorinated solvents and plating wastes represent the majority of the hazardous wastes disposed of on site. Liquid and semi-liquid wastes were brought to the site in drums, and some of the solvents were reportedly poured onto the ground and burned. Some of the emptied drums were reportedly sent to be recycled.

A review of the Guernsey County General Health District's records of the Fultz Landfill's 1974 and 1979 Solid Waste Disposal Questionnaires indicated a total solid waste volume of approximately 35 tons per operating day, or 11,000 tons per year. These records also indicate the following distribution of the types of wastes received regularly:

- 3% construction/demolition debris.
- 25% household.
- 32% industrial.
- 40% commercial.

The USEPA Region V conducted a Responsible Party Search (RPS) for the Fultz Landfill site in April 1983. The RPS identified several potentially responsible parties (PRPs) in connection with hazardous waste disposal at the site. Of the several possible parties listed, only three of the companies provided documents confirming shipment of hazardous wastes to the Fultz Landfill site. One generator reported that plating sludges were sent to the Fultz Landfill site during the period 1971 to 1981. Another generator reported that the following RCRA hazardous wastes were sent to the Fultz Landfill site during the period 1969 to 1980:

- Rollwash sludge; non-flammable liquids (F006).
- Triblend (trichloroethylene); flammable liquids (F001).
- Waste paint; flammable liquids (D001).
- Waste paint; flammable solids (D001).
- Rags; non-flammable solids.

The types of chemicals and compounds associated with the above hazardous wastes generally include hazardous metals, cyanide, chlorinated and non-chlorinated organic solvents, and phthalates.

III. Highlights of Community Participation

The RI/FS Report and the Proposed Plan for the Fultz Landfill site were released to the public for comment on June 27, 1991. These documents were made available to the public in both the administrative record and an information repository maintained at the USEPA Docket Room in Region V and at the Guernsey County District Public Library Main Branch and Byesville Branch. The notice of availability for these documents was published in The Daily Jeffersonian in Cambridge, Ohio on June 27, 1991. The public comment period on the Proposed Plan was from June 27, 1991 to July 27, 1991. In addition, a public meeting was held on July 11, 1991, in Byesville, Ohio. At this meeting, representatives from USEPA and the OEPA presented the Proposed Plan and answered questions about the site and the remedial alternatives under consideration. A response to the comments received during this period is included in the Responsiveness Summary, which is part of this Record of Decision (ROD). See Attachment 2.

IV. Scope and Role of Response Action Within Site Strategy

As with many Superfund sites, the problems at the Fultz Landfill site are complex. The Fultz Landfill Remedial Investigation (RI) studied the contaminant source area (landfill), soils, surface water and sediments, leachate and sediments surrounding leachate seeps, groundwater (both shallow aquifer and deep "coal mine" aquifer), and air. Numerous carcinogenic and non-carcinogenic contaminants were detected in most media sampled.

Results of the RI concluded that groundwater and leachate as well as airborne contaminants emanating from the site, pose unacceptable risks to human health and/or the environment. The USEPA has identified four remedial action objectives:

1. Reduce potential for risks to human health associated with use of groundwater from either the shallow aquifer or the deeper coal mine aquifer.
2. Reduce risks to human health associated with the inhalation of airborne contaminants from the landfill area.
3. Reduce risks to human health associated with the future use of groundwater from either the shallow aquifer or the deeper coal mine aquifer.
4. Reduce risks to the environment associated with excessive manganese concentrations in the on-site surface waters.

This ROD addresses all of the above mentioned remedial action objectives. By capping the landfill and hydraulically containing, extracting and treating groundwater and leachate emanating from the landfill, this remedial action addresses the principal risks caused by the deposition of liquid hazardous substances, to the maximum extent practicable. Extraction and treatment of groundwater in the shallow aquifer will also preclude the migration of contaminants into the deeper coal mine aquifer by both reduction of the level of contaminants in the shallow aquifer and by lowering the water table and thereby reducing the exposure of groundwater to contaminants in the subsurface of the landfill. Collecting leachate and capping the landfill will reduce human health risks associated with inhalation of airborne contaminants from the landfill and reduce risk to the environment due to excessive concentrations of manganese. This is the first and final remedy for the Fultz Landfill site.

V. Summary of Site Characteristics

Table 1 presents a summary of the chemicals detected during the RI at the Fultz Landfill site and indicates which chemicals were site related. A description of site characteristics and the chemicals detected by location and media type follows.

A. SITE CHARACTERISTICS

The hydrogeology of the Fultz Landfill site area is complex due to the underground and surface (strip) coal mining on and adjacent to the site. The conceptual model of groundwater flow at the Fultz Landfill site is a two-

Six inorganic chemicals were detected above background in the leachate sediment samples, including calcium, iron, silver, selenium, thallium and cyanide.

3. Pond Water and Sediment Contamination

Surface water and sediment samples were collected from all six of the ponds on site. Trichloroethene was detected at a concentration of 1.75 μg/l in Pond 1. Chlorobenzene, chloroform and 1,1,1-trichloroethane were detected in the sediments of all ponds. In addition to these compounds, phthalates were detected in the sediments of Ponds 1, 3, and 4. Manganese was the only inorganic chemical regularly detected above background, in the pond water samples.

4. Shallow Aquifer Contamination

The eastern shallow aquifer within the influence of the eastern groundwater capture system contained relatively low concentrations of carbon disulfide, chloroethane, 1,2-dichloroethene, ethylbenzene, 4-methyl-2-pentanone, vinyl chloride, xylenes, and bis(2-ethylhexyl)phthalate).

All of the metals analyzed were detected above background concentrations, with barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese and vanadium present in concentrations greater than 5 times the background concentrations. Contaminants in the eastern shallow aquifer have the potential of moving into the deep mine aquifer via Pond 2 and the coal barrier routes. The coal barrier route is formed by unmined coal which was left in-place, between the shallow and coal mine aquifers. See Figure 3.

The western shallow aquifer contained low concentrations of 1,2-dichloroethene, ethylbenzene, toluene, xylenes and bis(2-ethylhexyl)phthalate which were found mostly in a well that was screened in the landfill.

Some metals detected at off-site well nest M5/M6 were detected in on-site wells immediately downgradient from the landfill. Concentrations were higher in the well closer to the landfill (Well M5), than in the well M6, which is further from the landfill. Metals concentrations in Well M5 that were elevated above the GW004 background sample include arsenic (136 μg/l), barium (2120 μg/l), copper (277 μg/l), lead (150 μg/l), manganese (5,560 μg/l), mercury (0.4 μg/l) and vanadium (126 μg/l). Because groundwater gradients in the western shallow aquifer indicate that groundwater flows from the western half of the site to the sand and gravel aquifer under Wills Creek, it is probable that the metals detected in Well M5 are site-related.

5. Deep Mine Aquifer Contamination

The deep mine aquifer groundwater near the eastern groundwater capture system contained elevated concentrations of most of the metals found in the shallow aquifer, but did not contain any of the organics found in the shallow aquifer. The deep mine aquifer groundwater near the coal barrier route was found to contain elevated concentrations of only a few metals, but also contained low concentrations of organics including vinyl chloride, 1,2-dichloroethene, and benzoic acid. The vinyl chloride may be a biodegradation by product of the trichloroethene reportedly disposed of in the landfill.

The deep mine aquifer contaminants reflect the effects of contaminated groundwater moving from the shallow aquifer through the coal barrier route into the deep mine aquifer. The contaminants found in the deep mine aquifer at this location may also reflect the effects of contaminated groundwater moving from the bedrock via secondary permeability in the rocks underlying the southern half of the landfill.

aquifer system: the shallow aquifer and the coal mine aquifer. See Figure 4.

1. The shallow aquifer system is a local water table aquifer generally limited to the unconsolidated valley sediments and strip mining spoils in stream valley A. The overall groundwater flow direction in the stream valley A is from east to west, with the exception of the region around Ponds 2 and 2A, where there is a depression in the water table between Ponds 1 and 2 that forms a groundwater capture, defined as the "Pond 2 groundwater capture area," which causes a groundwater divide, splitting the shallow aquifer into eastern and western systems.

a. Eastern system groundwater flow is dominated by radially inward gradients centered around Wells M3, M10, and GWE04, and the Pond 2 and 2A areas. This inward gradient makes groundwater flow down into the shallow aquifer and then to the deeper coal mine aquifer, and acts as a communication point between the two aquifers whereby contaminants in the shallow aquifer migrate into the deeper coal mine aquifer. This is referred to as the eastern groundwater capture system. See Figure 5.

b. Western system groundwater flow is west toward Wills Creek. The flow originates partly from the mine spoil areas on the north and south sides of Stream A, and partly from the western half of the Fultz Landfill site. The groundwater then flows west beneath I-77 and into Wills Creek.

2. The coal mine aquifer system is a confined to partially-confined aquifer that has formed in the abandoned Ideal Coal Mine due to the flooding of the inter-connected underground mine workings of the Upper Freeport Coal. See Figure 3. Groundwater flow directions lead from the Fultz Landfill site to the Byesville Plant No. 2 well. The withdrawal point for the Byesville Plant No. 2 is approximately one mile south of the site. The City of Byesville uses the coal mine aquifer system as a source of municipal water.

In addition to the shallow and coal mine aquifers, groundwater may also seasonally occur above perching layers in intact bedrock above the mined Upper Freeport Coal Seam. See Figure 4.

B. SITE CONTAMINATION

1. Surface Soil Contamination

The following organic chemicals were detected in the on-site samples: acetone, di-n-butylphthalate, methylene chloride, tetrachloroethene and toluene. Selenium was the only inorganic chemical found in the on-site soil samples at concentrations above background.

2. Leachate and Leachate Sediment

Several organic chemicals were detected in the leachate water, including acetone, benzene, benzyl alcohol, bis(2-ethylhexyl)phthalate, chlorobenzene, chloroethane, diethylphthalate, ethylbenzene, 2-methylphenol, 4-methylphenol, n-nitrosodiphenylamine, naphthalene, phenol, toluene and xylenes. The concentrations ranged from 2 $\mu g/l$ for benzene, to 150 $\mu g/l$ for ethylbenzene.

The following inorganic chemicals were detected in the leachate water at levels above the background range: barium, calcium, chromium, magnesium, manganese, potassium and sodium.

Several organic chemicals were detected in the leachate sediment samples including acetone, bis(2-ethylhexyl)phthalate, butylbenzylphthalate, benzo(a)anthracene, chlorobenzene, 1,4-dichlorobenzene, 3,3-dichlorobenzidene, di-n-octylphthalate, ethylbenzene, dibenzofuran, fluoranthene, naphthalene, phenanthrene, methylene chloride, n-nitrosodiphenylamine, toluene and xylenes.

6. Chemicals in the Background Environment

Fourteen polynuclear aromatic hydrocarbons (PAHs) were detected in the Phase II background soil, sediment, and water samples. PAHs can be associated with coal, coal tar or other coal distillation products, as well as coal and petroleum combustion products. Because they are common trace chemicals in the environment, PAHs were not attributed to the landfill based on the available background data and screening criteria. Aside from the typical metals normally associated with coal such as iron and manganese, several other heavy metals have been documented in the literature as being associated with coal pile leachate, including arsenic, antimony, and selenium. In order for a compound to become a Contaminant of Potential Concern (COPC), it would have to be present at twice (2X) the detected background concentration. In the RI, if a contaminant was found on site and not in background samples, it would be considered a COPC.

C. ROUTES OF MIGRATION

1. Migration through Surface Water and Sediment

Contaminated surface water at the Fultz Landfill site is present in the leachate seeps around the base of the landfill. Contamination in these seeps results from the infiltration of precipitation into the landfill surface, and subsequent percolation through the wastes. Leachate seeps on the eastern side of the landfill enter Pond 2, and the water in Pond 2 ultimately infiltrates into the groundwater system. Leachate seeps on the western side of the landfill enter Stream A downgradient of the site, which in turn flows into Wills Creek.

Many of the contaminants in the leachate water and sediment are the same as those detected in groundwater, the concentrations of the contaminants are an order of magnitude higher in the seep samples. Lower contaminant levels are seen in the groundwater because the leachate is diluted when it mixes with the groundwater.

2. Migration within Groundwater

Contaminated groundwater beneath the eastern half of the landfill flows to the deep mine aquifer by two main routes: (1) north through a pathway created by the intersection of the strip mine and deep mine near Ponds 2 and 2A, and (2) south through potential mining-related breaches or natural fractures in the coal barrier that separate the shallow and deep mine aquifers.

Groundwater from the western side of the landfill flows north towards the western end of Stream A and into Wills Creek. Groundwater infiltrating into the bedrock moves mostly via unsaturated flow into the deep mine. In areas where the bedrock is undermined, contamination may also be transported through subsidence fractures.

3. Migration into and through Air

Volatile compounds can migrate from the soil, leachate, and/or surface water into the air. Of the several volatile organic compounds which were found in the soil, leachate, or surface water, only benzene, toluene, and acetone were detected during the air monitoring survey. See Figure 10 for exact locations of air monitoring points.

VI. <u>Summary of Site Risks</u>

Presented in the following section is a discussion which provides an indication of the actual and potential risks to human health and the environment posed by conditions at the Fultz Landfill site. This information supports the decision to take remedial action at the Fultz Landfill site.

1. **Human Health Risks**

A. Media of Concern

Chemicals detected in surface water and sediment, surface soil, groundwater, leachate and sediment, and air are identified for evaluation in the risk assessment.

B. Contaminants of Potential Concern and Concentrations for each Medium

1. Groundwater - Groundwater samples were collected from monitoring wells (Figure 5) as well as from several residential wells (Figure 6) and the Byesville Plant No. 2 well. Monitoring well data from Phases I and II were combined in the risk assessment in order to provide a more complete data base that is more representative of the range of groundwater quality that could occur at the site. Groundwater data from the monitoring wells were presented separately for the shallow aquifer and the coal mine aquifer. Data from the residential wells and the Byesville water supply well were evaluated individually by well.

a. Shallow Aquifer

The shallow aquifer well group is comprised of 15 wells that are screened in the alluvial sediment and strip mine spoil materials on site, along Stream A and in the bedrock immediately beneath the landfill. See Figure 5. Data from the shallow aquifer on-site wells is presented in Table 2.

b. Coal Mine Aquifer

Four monitoring wells are screened in the coal mine aquifer located in the Upper Freeport Coal seam. Data from the deep mine aquifer wells were summarized in Table 3.

c. Off-Site Residential Wells

Five residential wells in the area and one background well (RW004) were sampled. A data summary for the six residential wells is presented in Table 4.

d. Byesville Water Supply Well (Plant No. 2)

The City of Byesville operates two pumping and treatment plants for the supply of community water. Plant No. 2 pumps groundwater from the deep mine aquifer east of the city. The average of the untreated sample and its duplicate as well as the treated sample results are presented in Table 5.

2. Leachate and Sediment around Leachate Seeps - Phase II RI data is used for the evaluation of risk based on the leachate seeps. The leachate sampling locations are shown on Figure 7. Data from samples of leachate and sediment around leachate seeps are summarized in Tables 6 and 7, respectively.

3. Surface Water and Sediment - Phase II RI surface water and sediment data are used in the risk assessment. Surface water and sediment samples were collected from mid-stream or mid-pond at mid-depth from two locations on Stream A (upstream and downstream of the landfill), from five of the ponds, and from four locations along Wills Creek. See Figure 7 for exact sampling locations.

a. Stream A and Ponds

Surface water and sediment data for Stream A and the ponds are presented in Tables 8 and 9, respectively.

b. Wills Creek

Tables 10 and 11 present the data results for the Wills Creek surface water and sediment, respectively.

4. Soils - Surface soil samples were collected from the Fultz Landfill site from ten locations. In addition, three off-site locations were sampled to represent background conditions. The sampling locations are indicated on Figure 8, and analytical summaries for the on-site surface soil samples and the background surface soil samples are presented in Table 12.

5. Air - An ambient air quality monitoring survey was conducted to measure the total concentration of volatile organic compounds in the ambient air at the site. Seven air sampling stations were established at various locations around the site. The sampling locations are indicated on Figure 10. The frequencies of detection and the maximum concentrations of detected chemicals are presented in Table 13.

2. Exposure Assessment

<u>Exposure Pathways</u>

Exposure pathways (the link between the source and receptor), by which human populations could be exposed to contaminants are defined by a source and mechanism of chemical release to the environment, an environmental transport medium for the released chemical, a point of potential exposure by the receptor with the medium (i.e., the "exposure point"), and a route of exposure (i.e., inhalation, ingestion, dermal contact).

1. Current Use Scenario

Exposure pathways that were quantitatively evaluated under residential land use conditions were:

- direct contact with sediments in Stream A and its ponds by children and teenagers;
- direct contact with sediments in Wills Creek by children and teenagers;
- direct contact with surface water in Stream A and its ponds by children and teenagers;
- direct contact with surface soil by children and teenagers;
- ingestion of groundwater from the Byesville water supply by off-site (Byesville) residents and inhalation exposure via showering;
- ingestion of groundwater by nearby residents (inhalation exposure via showering will be qualitatively evaluated);
- infrequent direct contact with leachate seeps by children and teenagers;
- infrequent direct contact with leachate sediments by children and teenagers; and

- direct inhalation of airborne chemicals by nearby residents.

2. Future Use Scenario

Exposure pathways that were quantitatively evaluated under residential land use are:

- direct contact with surface soil by hypothetical residents on the Fultz Landfill site;
- ingestion and inhalation (while showering) of groundwater from the shallow aquifer by hypothetical residents on the Fultz Landfill site; and
- ingestion and inhalation (while showering) of groundwater from the deep aquifer by hypothetical residents on the Fultz Landfill site.

Exposure Point Concentrations

Exposure point concentrations were derived for evaluating a reasonable maximum exposure (RME) case. They represent possible upper bound exposures for a typical individual by combining reasonable maximum exposure estimates with upper bound toxicity criteria. The upper 95th confidence limit of the arithmetic mean concentration for each chemical is combined with reasonable maximum values describing the extent, frequency, and duration of exposure to estimate Chronic Daily Intakes (CDIs) for the RME case.

Exposure point concentrations used to estimate risks for inorganic chemicals of concern are based on total inorganic analytical results (i.e., non-filtered samples) for groundwater and surface water. Dissolved estimates of inorganics were not used in this risk assessment because dissolved estimates may tend to underestimate exposure (the screens on potable wells are not as fine as the filter systems used to analyze dissolved concentrations). An assumption is that exposure point concentrations will remain constant over the exposure period assumed under the different exposure scenarios evaluated. This is a reasonable assumption for persistent chemicals or where a large reservoir of chemicals exists.

CDIs were used to predict potential human intakes of chemicals of concern. Concentrations of chemicals in relevant environmental media at points of potential exposure points were used to estimate CDIs. CDIs are expressed as the amount of a substance taken into the body per unit body weight per day, or mg/kg-day. A CDI is averaged over a lifetime for carcinogens and over the exposure period for non carcinogens. Estimates of CDIs are then used to predict the potential health risks associated with exposures to carcinogens and the potential for adverse noncarcinogenic health effects.

The USEPA has not derived a Reference Dose (RfD) for lead, one of the selected chemicals of concern listed in the risk assessment. Exposures to lead were not evaluated by deriving a CDI. Instead a pharmacokinetic model (the Integrated Uptake/Biokinetic [IU/BK] Model) developed by the USEPA was used to evaluate the impact of potential lead exposures on blood lead levels in young children.

For direct contact with sediments from on-site soil and sediments, the risk assessment assumed that children and teenagers, from 6 to 16 years of age would be exposed 109 days per years for 10 years. To estimate dermal exposures, the amount of sediment accumulation on skin, the area of skin exposed, and the amount of chemical absorption are defined in the RI. An estimate of the amount of sediment accumulation on skin of 1.45 mg sediment/cm^2 for the RME case is used for this pathway based on an estimated average soil accumulation rate and adjusted to account for potential differences between sediment and soil adherence to skin. The surface area of exposed skin was calculated assuming the hands, arms, legs, and feet (6,810 cm^2) would be exposed for the RME case (i.e., assuming children play in the sediments). Thus, sediment contact rate (in mg sediment/day) was calculated by multiplying the sediment accumulation rate of 1.45 mg/cm^2 by the exposed skin area (in cm^2/day).

For incidental ingestion of soil and leachate sediment, a weighted average ingestion rate for the 6- to 16-year age period was calculated based on values provided for soil. The weighted average ingestion rate was a conservative estimate (6- to 16-year olds), based on the results from a recent study on soil ingestion among 1 to 4 year olds.

Many of the assumptions used in the risk assessment when evaluating exposure point concentrations and CDIs under current and future use scenarios for ingestion of groundwater (shallow and deep aquifers) and inhalation while showering with groundwater (shallow and deep aquifers) are similar. Parameters used to evaluate ingestion of groundwater for current and future use scenarios are a person weighing 70 kg ingesting 2.0 l/day for 365 days/year over a 70 year period. For inhalation of contaminants while showering with groundwater, a Foster and Chrostowski model was used to assess the possible inhalation exposures. Section 6.3.5- Estimation of Human Exposure in the RI can be referred to for further discussions of parameters and concentrations used to determine exposure point concentrations.

3. Toxicity Assessment

In the risk assessment individual pollutants are separated into two categories of chemical toxicity depending on whether they exhibit noncarcinogenic or carcinogenic effects. For the purpose of assessing risks associated with potential carcinogens, the scientific position is that a small number of molecular events can cause changes in a single cell or a small number of cells that can lead to tumor formation.

For chemicals exhibiting noncarcinogenic effects, it is believed that organisms have protective mechanisms that must be overcome before the toxic endpoint is manifested. For example, if a large number of cells perform the same or similar functions, it would be necessary for significant damage or depletion of these cells to occur before an effect could be seen. This threshold view holds that a range of exposures from just above zero to some finite value can be tolerated by the organism without appreciable risk of causing the disease. Some chemicals can also exhibit both carcinogenic and noncarcinogenic effects.

A. Cancer Potency Factors for Contaminants of Concern that are Carcinogens

Cancer potency factors (CPFs) have been developed by the USEPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, which are expressed in units of (mg/kg-day)$^{-1}$, are multiplied by the estimated intake of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the CPF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Cancer potency factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied. Health criteria for potentially carcinogenic chemicals of concern are presented in Table 14.

B. Reference Doses for the Contaminants of Concern that have Noncarcinogenic Effects

Reference doses (RfDs) have been developed by USEPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure levels for humans, including sensitive individuals, that are not likely to be without an appreciable risk of adverse health effects. Estimated intakes of chemicals from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans). These uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur. Health criteria for noncarcinogenic chemicals are presented in Table 15.

C. Health effects for Lead

The USEPA has not developed an RfD or Cancer Potency Factor for lead. Chronic health effects associated with lead exposure have been related to elevated lead concentrations in the blood. Investigations have indicated that the adverse effects of lead are dependent upon the age of the exposed individual. Exposures to lead are highly variable, the same daily dose in mg/kg/day may have different effects on individuals of different ages. Therefore, measures of total lead in the body [via blood lead levels (PbB)] are believed to be more accurate correlates of the potential effects of lead than are average daily exposure levels (in mg/kg/day).

The Center for Disease Control considers a blood lead level of 25 µg/l or greater in combination with an erythrocyte protoporphyrin (EP) level of 35 µg/l or greater to be potentially toxic. More recent studies suggest that much lower levels, in the 10-15 µg/dl range, may be a public health concern. In the risk assessment, the health criterion for lead is considered to be in the 10-15 µg/dl range. Table 16 presents the total lead uptake for all sources combined.

4. Risk Characterization

A. Carcinogenic Risks

Excess lifetime cancer risks are determined by multiplying the intake level with the cancer potency factor. These risks are probabilities that are generally expressed in scientific notation (e.g., $1x10^{-6}$ or 1E-6). An excess lifetime cancer risk of $1x10^{-6}$ indicates that, as a plausible upper bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under the specific exposure conditions at a site. The following tables present quantified carcinogenic risk of each contaminant along with combined carcinogenic risks.

Evaluated in the risk assessment were:

Current Use:

1. Direct Contact with Stream A Sediments, Table 17
2. Direct Contact with Stream A Surface Water, Table 18
3. Direct Contact with Soil, Table 19
4. Ingestion of Groundwater, off-site Residential Wells, Table 20
5. Direct Contact with Leachate, Table 21
6. Direct Contact with Leachate Sediments, Table 22
7. Inhalation of Airborne Contaminants, Nearby Residents, Table 23

Future Use:

1. Direct Contact with Soil, Table 24
2. Ingestion of Groundwater from Shallow Aquifer, Table 25
3. Ingestion of Groundwater from Deep Mine Aquifer, Table 26
4. Inhalation while showering with Groundwater from the Shallow Aquifer, Table 27

5. Potential for Adverse Effects from Exposure to Lead, Table 16

B. Noncarcinogenic Effects

Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as the hazard quotient (HQ) (or the ratio of the estimated intake derived from the contaminant concentration in a given medium to the contaminant's reference dose). By adding the HQs for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the Hazard Index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. The following tables present the potential for noncarcinogenic effects for each contaminant of concern along with the combined potential for noncarcinogenic effects.

Current Use:

1. Direct Contact with Stream A Sediments, Table 17
2. Direct Contact with Stream A Surface Water, Table 18
3. Direct Contact with Soil, Table 19
4. Ingestion of Groundwater, off-site Residential Wells, Table 20
5. Direct Contact with Leachate, Table 21
6. Direct Contact with Leachate Sediments, Table 22
7. Inhalation of Airborne Contaminants, Nearby Residents, Table 23

Future Use:

1. Direct Contact with Soil, Table 24
2. Ingestion of Groundwater from Shallow Aquifer, Table 25
3. Ingestion of Groundwater from Deep Mine Aquifer, Table 26
4. Inhalation while showering with Groundwater from the Shallow Aquifer, Table 27
5. Inhalation while showering with Groundwater from the deep mine aquifer, Table 28

<u>UNCERTAINTIES IN RISK ASSESSMENT</u>

The procedures and inputs used to assess risks in the risk assessment for the Fultz Landfill site, as in all such assessments, are subject to a wide variety of uncertainties. Uncertainties regarding the human health assessments are summarized in Table 29, along with their likely effects on risk estimation. In general, the main sources of uncertainty in a risk assessment are:

- Environmental sampling and analysis;
- Exposure parameter estimation; and
- Toxicological data

5. Environmental Assessment

Methodology used in the environmental assessment roughly parallel those used in human health risk assessment, and follow currently released guidance. Potentially exposed populations (receptors) are identified, and then information on exposure and toxicity are combined to derive estimates of risk. Some of the descriptions presented in the Environmental Assessment were not based entirely on site-specific information but rather on a thorough literature search of the region. Risk estimates are limited to the population (species) level, because data on community and ecosystem level responses to environmental pollutants are generally lacking. The uncertainties associated with the Environmental Assessment of this site were not included in Table 29.

Terrestrial Ecosystem

The region surrounding the landfill is a mixture of open fields used for grazing cattle and woodland areas of deciduous forest. Goldenrod, Queen Anne's lace, bull thistle, clover, milkweed and a mixture of grasses are found in the open grassland areas surrounding the site. Tree species commonly found in mixed-hardwood stands in this region include beech, black birch, black cherry, black locust, elm, hickory, red maple, red oak, sassafras, white oak, and yellow birch. May apple, pink lady's-slipper, and wintergreen are plants that may be found in the herbaceous layer of hardwood forests.

The woodlands in the vicinity of the Fultz Landfill site may provide breeding and feeding areas for resident and migratory birds, as well as mammals, reptiles, and amphibians. Amphibians in the woodland areas may include Fowler's toad, red spotted newt, and four-toed salamander. Black racer and the eastern box turtle are probably the dominant reptiles of the woodlands. Bird species likely to use the open grassland areas and woodlots include robin, American goldfinch, eastern meadowlark, cardinal, barn swallow, pigeon, mourning dove, vireos, warblers and other passerine species. The belted kingfisher and green-backed heron inhabit areas around Stream A and on-site ponds. Raptor species common in the woodlands include red-tailed hawk, turkey vulture, American Kestrel, and screech owl. Mammalian species include eastern cottontail, eastern mole, masked shrew, meadow vole, opossum, raccoon, shorttail shrew, star-nosed mole, white-footed mouse, white-tailed deer, and woodchuck. During site investigations, numerous signs of white-tailed deer were noticed.

Aquatic Ecosystem

Chemicals of potential concern were identified in the sediments of Wills Creek and the surface water and sediments of Stream A and on-site ponds. Aquatic species that may be found in Wills Creek and Stream A and the associated retention pond include plankton and macroinvertebrate species, crayfish, common shiners, sunfish, suckers, and striped bass. In addition, several mammalian species may feed in and around these surface water bodies, including beaver, marsh rice rat, masked shrew, mink, and muskrat. During previous site visits, beaver activity was noticed along Pond 1. Water snakes, water turtles, frogs, and algae were noticed along Stream A, the ponds, and Wills Creek. No sport fish were noticed in these surface water bodies. The wetlands surrounding on-site ponds, may be impacted by the site.

Potential Exposure Pathways

Selection of indicator species is driven by several factors, including species diversity at the site, the potential for exposure, and the availability of toxicity data.

The white-tailed deer was selected as the indicator species for evaluating this pathway because of its high potential for exposure (numerous signs of deer were noticed along the banks of the on-site ponds). Potential impact from ingesting of surface water by white-tailed deer was evaluated by comparing the concentrations of chemicals of potential concern in surface water with recommended maximum dietary levels for livestock drinking water developed by NAS (1980) and Puls (1988). Recommended maximum dietary levels for livestock are presented in Table 30. These levels provide a basis for comparison as to the maximum dietary levels for deer.

Concentrations of manganese detected in Pond 1, Pond 1A, Pond 2, Pond 3, Pond 4, Pond 5, and downstream of Pond 5 exceeded the recommended maximum dietary level for livestock developed by Puls (1988). The highest detected concentration of manganese in surface water exceeded the maximum dietary level for livestock by a factor of 30. Therefore, white-tailed deer that ingest surface water from these surface water bodies around Fultz Landfill may be adversely affected.

Risk Assessment Conclusions

Major conclusions presented in the risk assessment for the Fultz Landfill site are presented in Table 31. In summary, the major risks at the site are posed by ingestion of groundwater and inhalation while showering with groundwater from either the shallow aquifer or the deeper coal mine aquifer, based on future residential use of the landfill. The possibility of residential development on or near the landfill is based on the Ohio Department of Development projection for population growth for the towns of Byesville and Cambridge and the corresponding need for additional land necessary to develop residential areas. The additional population will create a greater demand for water thereby increasing the use of, at a minimum, the deep mine aquifer as a water supply source. This increased demand could result in a reduction in the present dilution of contamination in the deep mine aquifer and could increase the migration of contamination from the shallow aquifer to the deep mine aquifer. The cumulative carcinogenic risk posed by ingestion of groundwater or inhalation while showering with groundwater from either the shallow aquifer or the deeper coal mine aquifer would be $1x10^{-3}$, which does not fall within the USEPA acceptable risk range of $1x10^{-4}$ to $1x10^{-6}$. In addition, the environmental risk assessment concluded that the site poses an unacceptable risk to white-tailed deer.

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

VII. <u>Description of Alternatives</u>

Alternatives discussed in the FS for the Fultz Landfill site were developed by combining the technologies and process options and evaluating them against remedial action objectives. The remedial action objectives considered are:

1. Reduce potential for risks to human health associated with the use of contaminated groundwater from either the shallow aquifer or the deeper coal mine aquifer.

2. Reduce risks to human health associated with the inhalation of airborne contaminants from the landfill area.

3. Reduce risks to human health associated with the future use of groundwater from either the shallow aquifer or the deeper coal mine aquifer.

4. Reduce risks to the environment associated with excessive manganese concentrations in the on-site surface waters.

The remedial action alternatives discussed in the FS and a description of them are as follows:

Alternative No. 1:	No Action
Alternative No. 2:	Institutional Controls and Monitoring
Alternative No. 3:	Multi-layer Cap
Alternative No. 4:	Multi-layer Cap with Groundwater Extraction and Treatment
Alternative No. 5:	On-site RCRA Landfill
Alternative No. 6:	Multi-layer Cap with Subsurface Barrier
Alternative No. 7:	Groundwater Extraction (without cap)
Alternative No. 8:	Cap with Upgrade of the Byesville Water Treatment

Plant.

Alternative No. 9: On-site Landfill with Groundwater Extraction

Alternative No. 10: Coal mine aquifer cut-off barrier.

ALTERNATIVE 1: NO ACTION

The no action alternative is a no cost alternative that is required to be retained by the National Contingency Plan (NCP). Under this alternative, the site would be left as is without taking any steps to reduce the risks of exposure to contamination. The no action alternative can therefore be used as a baseline for comparison to other alternatives developed.

ALTERNATIVE 2: INSTITUTIONAL ACTIONS AND MONITORING

This alternative attempts to meet the remedial action objectives 1, 2, and 3 by restricting access to the site thereby preventing human exposure. Remedial action objective 3 is addressed also by restrictions on future use of the site for water supplies and habitation.

The components of Alternative 2 are as follows:

1. Institutional Controls
2. Site Fence
3. Alternate Water Supply
4. Monitoring

1. Institutional Controls

Institutional controls would be sought to reduce exposure to site contaminants by legally restricting access to the site. Deed restrictions on land and water use on and adjacent to the landfill would be sought from the landfill owner and nearby residents. A public information program to advise nearby residents of the nature of the problem at the site would be established. The USEPA would request local municipalities to enact local and zoning ordinances that will forbid future use of the site that would expose humans to contamination, and restricting the drilling of wells and the use of groundwater and surface water.

2. Site Fence

Prior to the commencement of any work on the Fultz Landfill site and immediately following initial mobilization, an equipment staging/site admittance area would be constructed. A 6-foot high chain-link fence approximately 10,000 feet in length, would be installed around the entire Fultz Landfill site to restrict access and reduce direct exposure to surface contamination. The fence will be topped with barbed wire and equipped with warning signs posted at 100-foot intervals along the fence. Periodic inspection and maintenance of the fence will also be required. Locked gates will be installed to permit controlled access to the site for monitoring and maintenance.

3. Alternate Water Supply

A water supply inventory would be conducted to identify all residential wells that are downgradient and affected by the Fultz Landfill site. The depth of each well would be ascertained to determine if it is screened in one of the potentially contaminated aquifers. A sample would be taken from each well and analyzed using analytical methods appropriate to characterize water intended for drinking for the full Contract Laboratory Program (CLP) Target Compounds List for organic contaminants (TCL) and the Target Analyte List for inorganic contaminants (TAL). Residential wells with site-related contamination that are found to present an unacceptable risk and contain groundwater concentrations above Maximum Concentration Levels (MCLs), would be connected to the municipal drinking water supply.

4. Monitoring

Long-term monitoring of air, surface water, leachate, groundwater, and sediments would be performed in accordance with Ohio Administrative Code 3745-54-90 through 99 and other applicable regulations for a minimum of 30 years to evaluate the migration of contaminants from the landfill and to monitor the effects of natural attenuation. The actual monitoring plan would be determined during remedial design. One possible monitoring plan could be as follows:

Ambient air monitoring would be performed quarterly at a minimum. Four samples obtained from the vicinity of the landfill (1 upwind and 3 downwind) would be analyzed for volatile contaminants. Ambient air monitoring would also be conducted during the remedial action implementation phase.

Quarterly monitoring of surface water and sediment would be performed at 2 locations in Wills Creek, two locations in Stream A and B, and one location in each of Ponds 1, 2, 3, and 6. Chemical analysis will consist of the full TCL and TAL. The purpose of this sampling and analysis would be to monitor the levels of various contaminants in Valley A, Valley B, and Wills Creek resulting from the discharge of the shallow and coal mine aquifers, or leachate from the landfill, to the ponds or streams.

Quarterly sampling of leachate at 8 locations would also be performed. The purpose of these samples will be to monitor any changes in the level of contamination in the leachate over time. Leachate will be analyzed for the same parameters as surface water/sediment.

For groundwater monitoring, existing regulations (Ohio Administrative Code 3745-27-10 and Ohio Administrative Code 3745-65-91) call for a minimum of one upgradient well and three downgradient wells. Because of the size and complexity of the Fultz Landfill site, additional monitoring would be performed. One potential groundwater monitoring plan would be as follows:

Shallow Aquifer: 10 points (8 existing wells, 2 new)
Coal mine Aquifer: 9 points (6 existing wells, 3 new)

Two new wells in the shallow aquifer would be needed to fill a data gap that exists downgradient of the existing landfill to the west. Three new coal mine aquifer wells would be needed downgradient of the existing landfill to the southeast to supplement GW005 and GW006 in detecting possible migration of contaminants towards the Byesville municipal well. One of the new coal mine aquifer wells would be installed southeast of the existing landfill in an area where the mine is constricted because contamination that might not be detected in other wells would be more likely to be observed in this area. See Figure 10.

Groundwater sampling would be performed semi-annually at a minimum. The above-referenced monitoring program should be sufficient to monitor contaminant migration both horizontally and vertically. Chemical analysis would consist of the full TCL and TAL. Five-year reviews would be instituted in order to re-evaluate the site conditions on a periodic basis. The reviews would include a detailed analysis of the long-term monitoring data, a temporal and spatial evaluation of contaminant migration and attenuation in various media, an assessment of current residual health risks, an evaluation of the effectiveness of the institutional controls, response to public comments or complaints received during the five-year period, and an evaluation of what additional remedial measures, if any, would be implemented based on the reviewed site conditions.

The capital cost of this alternative is $ 519,600. The Operation & Maintenance (O&M) cost is $ 109,400. The total present worth cost over a 30 year period considering an interest rate of 5% is $ 2,284,600. The time required to implement this alternative is less than 1 year. Key ARARs not addressed by this alternative are the Safe Drinking Water Act (SDWA) MCLs and Ohio standards regarding proper closure of a landfill.

ALTERNATIVE 3: MULTI-LAYER RCRA CAP

Closure of the existing landfill would be performed by installation of a 30 acre cap, gas venting system, and leachate collection system. The cap would meet the remedial action objectives 1, 3, and 4 by reducing the migration of contamination from the landfill into the shallow and coal mine aquifers and the production of leachate. A cap would meet remedial action objective 2 by preventing exposure through direct inhalation of airborne contamination. The cap would be designed to meet Ohio landfill closure requirements. A Subtitle C RCRA cap is necessary because of disposal of RCRA hazardous wastes after 1980. The components of Alternative 3 are:

1. Institutional Controls
2. Site Fence
3. Alternate Water Supply
4. Monitoring
5. Subsurface Structural Supports
6. Surface Water and Sediment Controls
7. Multi-layer Cap
8. Leachate Collection System
9. Wetlands Replacement

Institutional Controls, Site Fence and Alternate Water Supply
Items 1. through 3. of Alternative 2 would be performed.

4. Monitoring

Because the landfill would be capped with this alternative, and the leachate collected for off-site disposal, no leachate samples would be collected for analysis. Long-term monitoring of surface water, groundwater, combustible gas, and sediments will be performed in accordance with Ohio Administrative Code (OAC) 3745-54-90 through 99 and other applicable regulations for a minimum of 30 years to evaluate the migration of contaminants from the landfill and to monitor the effects of natural attenuation.

5. Subsurface Structural Supports

Subsurface support would be provided for the mine voids under the landfill to prevent damage of the cap by subsequent mine subsidence and to reduce the potential for bedrock fracturing between the landfill and the coal mine aquifer. There are two standard approaches to providing subsidence supports, namely, grout pillars and mine flushing.

a. Grout Pillar Method

The grout-pillar method would provide roof support by drilling into a mine cavity and installing wide pillars made of material similar to concrete. The pillars would be installed so that they achieve a minimum contact area (generally six feet in diameter) with the roof of the mine. The pillars would be built up in layers to prevent the concrete from slumping away. In areas where the mine is flooded, special admixtures are added to the mix to compensate for the water in the mine.

b. Mine Flushing Method

The mine flushing method would attempt to fill entire mine voids with a lower cost mixture, usually consisting of fly ash, cement, sand, and water. Sometimes coarser aggregate is used in sloping or flooded mines. The mix is pumped down a borehole into the mine with a large quantity of water. As the mix flows through the mined-out rooms, the solids settle out of the mix and the water flows through. After a time the solids build up from the mine floor to the roof providing support.

6. Surface Water and Sediment Controls

Part of Stream Valley A northeast of the existing landfill would be regraded to eliminate standing surface water, and divert runoff away from the landfill. This would include filling in Ponds 2, 2A, and 3 and constructing a clean water diversion channel in the approximate location of Stream A from the western end of Pond 1 to the culvert downstream of Pond 6 to divert runoff away from the landfill. In order to provide sediment control for earth disturbances resulting from capping the landfill, a sediment control pond would be constructed in an area to the northwest of Pond 6. The size of the sediment pond at maximum pool level would be equal to or greater than the combined area of Ponds 2, 2A, and 3. A sediment control ditch would be constructed at the base of the existing landfill to channel runoff from the landfill to the sediment control pond. The northern part of Valley A along the border of the existing landfill would be filled and graded to elevation 820 feet MSL to remove standing surface water from that part of the valley. Ponds 2, 2A, and 3 would be breached and filled in to avoid interference with the leachate collection system. The outlet elevation of Pond 1 would be reduced from elevation 814 feet MSL to elevation 808 feet MSL for the same purpose. This would cause an estimated 20% reduction in the size of the pond, while significantly reducing the potential for groundwater flow from Pond 1 to the leachate collection system.

7. Multi-layer Cap

A berm would be constructed of compacted clay along the northern side of the landfill to bring the toe of the cap up to elevation 835 feet MSL and reduce the overall slope of the cap to about 5-1/2%. Following the construction of the containment berm, a multi-layer cap would be installed over the entire 30 acre landfill area. A detail schematic of the multi-layer cap is presented in Figure 11. Cap layers would include (from the bottom up):

- Random earth fill required in places to grade off the existing landfill and establish an even slope of 5-1/2%;
- A synthetic drainage layer for gas collection with filter fabric above and below;
- A 24-inch thick compacted clay layer (10^{-7} cm/s permeability);
- A 40-mil HDPE synthetic liner;
- A synthetic drainage layer for infiltration with filter fabric above;
- A 30-inch thick random earth fill; and
- A 6-inch thick topsoil layer.

Surface and subsurface diversion drains at the top of the landfill would be used to collect and divert any water which might flow towards the landfill.

8. Leachate Collection System

The quantity of leachate that would be produced by the landfill once it is capped was estimated using the U.S.G.S. HELP model. The current rate of infiltration predicted by the HELP model is 4.2 inches per year or about 4.88 gallons per minute (GPM). This prediction corresponds well with the field estimates of the volume of seeps from the landfill as 2 to 4 GPM. After capping, the steady-state infiltration is predicted to be 0.02 inches per year or 0.02 GPM.

The leachate collection system would be installed along the northern side of the landfill to intercept groundwater leaving the landfill. It would consist of a subdrain similar to the upgradient groundwater diversion drain extending below the lowest elevation of landfill waste or about elevation 795 feet MSL. The rock drain would be sloped to a central sump from which the accumulated leachate can be pumped for off-site treatment or disposal. See Figure 12.

9. Wetlands Replacement

During the design and construction of Alternative 3, every effort would be made to minimize the disturbance of areas identified as wetlands. Since the disruption of the wetland environment is anticipated from proposed remedial activities, a study to delineate the extent of wetlands and develop a plan for remediation would be conducted. At a minimum, the wetlands replacement plan would include replacement or restoration of the ponds and surrounding habitat. Upon completion of construction, the clean water diversion channel would be re-routed into the sediment pond, and the base water level of the sediment pond would be raised to provide pond surface area equal to the area lost by the elimination of Ponds 2 and 3 and the lowering of the pool level of Pond 1. Every attempt would be made to provide a minimum of a 1 to 1 wetlands mitigation.

The capital cost of this alternative is $ 14,724,900. The O&M cost is $ 245,000. The total present worth cost over a 30 year period considering an interest rate of 5% is $ 18,906,900. The time required to implement this alternative is 3 years. Key ARARs addressed with this alternative are Ohio closure requirements for landfills, and SWDA MCLs.

ALTERNATIVE 4: MULTI-LAYER CAP, GROUNDWATER EXTRACTION AND ON-SITE TREATMENT

This alternative would attempt to meet the remedial action objectives in the same way as Alternative 3, with the added advantage that contaminated groundwater would be removed from the shallow aquifer and treated. The groundwater extraction and treatment system attempts to improve the effectiveness of Alternative 3 by directly intercepting a groundwater contaminant migration route and removing leachate directly from the existing landfill. The multi-layer cap, groundwater extraction and treatment system attempts to address the principal threat by containing the source material to the maximum extent practicable.

The components of Alternative 4 are:

1. Institutional Controls
2. Site Fence
3. Alternate Water Supply
4. Monitoring
5. Subsurface Structural Supports
6. Surface Water and Sediment Controls
7. Multi-layer Cap
8. Leachate Collection System
9. Extraction Well System
10. On-site Water Treatment Plant
11. Discharge of Treated Water To Surface Water
12. Wetlands Replacement

Components Similar To Alternative 3

With Alternative 4, Items 1 through 8 of Alternative 3 would be performed, with the exception that leachate would be discharged to an on-site treatment system rather than hauled off-site. Since an on-site treatment system would be needed to economically treat the volume of groundwater extracted from the shallow aquifer, it would be most cost-effective to treat the leachate in the same system rather than haul it off-site. Item 12 as described in alternative 3, would also be included with Alternative 4.

9. Extraction Well System

An array of extraction wells would be installed in the shallow aquifer to; 1) lower the water table in the landfill area, 2) intercept and hydraulically contain groundwater migrating into the deep-mine aquifer, and 3) collect contaminated groundwater for treatment thereby reducing the volume of hazardous liquids on site. The extraction well system is shown in Figure 13. For the purpose of containing contaminated groundwater between shallow and deep aquifers, five of the twelve extraction wells may have to be installed through the multi-layer cap and would have to be sealed to the liner to minimize infiltration. Pump tests would be conducted to determine the exact well production rate and zone of influence for each extraction well. Figure 13 also illustrates the estimated zone of capture.

10. On-site Water Treatment Plant

The process options for treatment that are being considered for remediation of leachate and groundwater at the Fultz Landfill are:

- Oxidation
- Precipitation
- Filtration
- Carbon Adsorption

In order to treat the water extracted from the shallow aquifer and the leachate produced by the existing landfill, an on-site water treatment plant would be installed which would reduce the contaminant levels sufficiently for discharge to surface water. Processes listed above can be combined into a treatment train capable of treating the compounds identified in leachate and groundwater at the Fultz Landfill site. It is currently estimated that the treatment system for the site must be capable of operating at rates of at least 15 gpm, that is, about 10 GPM from the extraction wells, 2 GPM from the leachate collection system, and 3 GPM excess capacity as a factor of safety.

The final treatment system used at the Fultz Landfill site must be capable of detoxifying or removing a number of inorganic compounds, volatile organic compounds, and semi-volatile organic compounds. The treatment system will be capable of removing, at a minimum, all chemicals that contribute to the carcinogenic risk above 10^{-6} and non- carcinogenic risk factors greater than 1 as defined in RI Chapter 6.

In addition, the effluent from the treatment system must meet all limitations established by the State of Ohio. For the purpose of a conceptual design of the treatment system we have considered Federal MCLs, MCLGs, Drinking Water Standards, and Ohio State Water Quality Standards for Wills Creek.

The final treatment system selection will be based on samples from the extraction system, after it is constructed and functioning. A bench scale treatability study would be conducted to determine the most efficient manner to treat contaminated leachate and groundwater.

The proposed treatment process would begin with the addition of an oxidizing agent, such as hydrogen peroxide, to oxidize the iron, arsenic, and other metals. A precipitant would then be mixed with the solution, which will be discharged to a clarifier where most of the solids will precipitate out, and be removed as a sludge. The sludge will be discharged to a filter press that removes moisture, increasing its solids content to about 30%. The sludge produced may be considered a RCRA hazardous waste and may be considered a Land Disposal Restricted (LDR) waste. Sludge produced from the on-site treatment system would be disposed of in accordance with applicable Federal Land Disposal Restrictions. If the sludge is found to be non-hazardous it would be disposed of in an approved landfill.

Clarified water would then be passed through a granular carbon filter to remove the remaining suspended solids. Effluent would be passed through a bed of granular activated carbon (GAC) as a polishing step to remove any remaining organic compounds. At periodic intervals, the spent carbon must be replaced with fresh carbon, and the used carbon either regenerated or disposed of in accordance with Federal Land Disposal Restrictions. If the spent carbon is to be regenerated, it must be treated in a unit that is in compliance with 40 CFR 264 Subpart X.

11. **Discharge of Treated Water To Surface Water**

Discharge of the treatment plant effluent will be to Stream A downstream of the sediment pond by way of a dedicated discharge pipeline. The discharge of treatment plant effluent would be in accordance with substantive requirements of a National Pollutant Discharge Elimination System (NPDES) permit.

The capital cost of this alternative is $ 15,759,700. The O&M cost is $ 218,000. The total present worth cost over a 30 year period considering an interest rate of 5% is $ 19,480,700. The time required to implement this alternative is 3.5 years. Key ARARs addressed with this alternative are Ohio closure requirements for landfills and SWDA MCLs for groundwater leaving the site, and NPDES requirements for discharge of water to surface water bodies.

ALTERNATIVE 5: ON-SITE LANDFILL

An on-site landfill was proposed to remove the contaminated municipal waste from its existing location and deposit it in a secure double-lined RCRA equivalent landfill. Fultz Landfill site property is large enough to permit the construction of a landfill in a side valley adjacent to Stream Valley A to the east of the existing landfill. See Figure 14.

The components of Alternative 5 are:

1. Institutional Controls
2. Site Fence
3. Alternate Water Supply
4. Monitoring
5. Over-excavation of the Underground Mine
6. Rock Underdrain
7. Erosion and Sediment Controls
8. Dewatering Facilities
9. RCRA Equivalent On-site Landfill
10. Wetlands Replacement

Institutional Controls, Site Fence and Alternate Water Supply, Items 1 through 3 of Alternative 2 would be performed as described. Item 10 as described in Alternative 3, would also be included with Alternative 5.

4. Monitoring

Because the new landfill would be lined and capped, and the leachate would be collected for off-site disposal, in accordance with Federal Land Disposal Restrictions, long-term monitoring of surface water, groundwater, sediments and combustible gas would be performed in accordance with all applicable regulations for a minimum of 30 years to evaluate the migration of contaminants from the landfill and to monitor the effects of natural attenuation. The actual monitoring plan will be determined during remedial design.

5. Over-excavation of the Underground Mine

Construction of a landfill on the eastern portion of the Fultz Landfill site property would require some treatment of the abandoned underground mine to remove the danger of subsidence. The same mine flushing procedure of Alternative 3 could be used to provide adequate support, but in the case of a new landfill where a disposal pit must be excavated for the installation of liners, leachate collection system, and waste disposal, it would be more cost-effective to continue the excavation down to the mine floor to eliminate the mine cavities and in-place coal. Over-excavation would be more reliable than mine flushing since the mine itself will be eliminated.

6. Rock Underdrain

As part of the procedure of elimination of the underlying coal mine, the excavated mine void would be backfilled with a 5-foot thick rock underdrain and 15 additional feet of low-permeability granular fill approved by the OEPA in an effort to maintain the water table at least 15 feet below the bottom of the landfill. See Figure 15.

7. Erosion and Sediment Controls

Prior to commencing any excavation for the new landfill, Stream Valley A would be regraded, and erosion and sediment controls would be installed. First, ponds 1, 2, and 2A would be drained and the sediments removed to a stockpile on the existing landfill. Ponds 2 and 2A will be backfilled and a clean water diversion channel constructed along the north side of Stream Valley A as shown in Figure 14. A sediment control pond would be excavated in an area to the west and north of Pond 6, and a temporary sediment control ditch constructed just south of the clean water diversion channel.

The sediment pond would remain after construction to replace pond water habitat eliminated by the filling of ponds 1, 2, and 2A, and the clean water diversion would be re-routed into the sediment pond after revegetation of all disturbed areas.

8. Dewatering Facilities

Temporary dewatering facilities consisting of well points and sump pumps would be required during the excavation of the landfill pit to eliminate the seepage of groundwater into the excavation. A line of well points would be installed along the northern edge of the proposed pit to lower the water table as needed during excavation. After the rock underdrain is installed, groundwater will drain under the backfill and the dewatering equipment will not be needed.

9. RCRA-Equivalent On-site Landfill

A landfill pit would be prepared as shown on Figures 14 and 15. After over-excavation and backfilling of the coal mine, the sides of the pit would be graded to the proper slope and a thirty-six inch thick layer of clay compacted to achieve a permeability of 10^{-7} cm/s would be installed. A synthetic double liner with leachate collection and leak detection systems using synthetic drainage netting would also be installed. A layer of filter fabric and a 12-inch-thick layer of sand would be placed on top of the uppermost drainage netting. The solid waste from the existing landfill would be placed on top of the sand layer. Before placement in the new landfill, solids from the existing landfill would be excavated and segregated into hazardous and non hazardous. After analysis, landfill material considered to be hazardous would be disposed of in an off-site USEPA approved landfill. Non-hazardous wastes would be compacted to reduce the volume of the waste and to reduce the potential for settlement within the new landfill, and disposed of in the new on-site landfill.

The capital cost of this alternative is $ 54,404,600. The O&M cost is $ 134,000. The total present worth cost over a 30 year period considering an interest rate of 5% is $ 56,766,600. The time required to implement this alternative is 7.5 years. Key ARARs addressed with this alternative are Ohio closure requirements for landfills and siting criteria for construction of new landfills.

ALTERNATIVE 6: MULTI-LAYER CAP WITH SUBSURFACE BARRIER

The purpose of this alternative is to isolate the landfill from infiltration, including lateral infiltration from the groundwater flowing through Stream Valley A and vertical infiltration through the ground surface. The cap would prevent infiltration of precipitation from the landfill surface and shallow groundwater from the south. At the same time the cap would lower the water table under the landfill by an estimated 3 to 7 feet. This would increase the potential for groundwater in the eastern side of the shallow aquifer to flow under the landfill thereby reducing contaminant flow southward, into the coal mine aquifer. A subsurface barrier around the west and north of the landfill would minimize the transport of contaminants by preventing groundwater from Stream Valley A from flowing under the landfill.

The components of Alternative 6 are:

1. Institutional Controls
2. Site Fence
3. Alternate Water Supply
4. Monitoring
5. Subsurface Structural Supports
6. Surface Water Controls
7. Multi-layer Cap
8. Leachate Collection System
9. Slurry Wall
10. Wetlands Replacement

Components Similar to Alternative 3

Items 1 through 8 of Alternative 3 would be performed with the exception that Pond 3 would not be removed. Item 10 as described in alternative 3, would also be included with Alternative 6.

9. Slurry Wall

A low-permeability, subsurface vertical barrier would be constructed around the eastern and northern sides of the existing landfill to divert groundwater in the shallow aquifer around the landfill as illustrated on Figure 16. A soil-bentonite slurry wall would work best in the mine spoil and alluvium encountered in Stream Valley A. After Stream Valley A is regraded, and the multi-layer cap with leachate collection is installed, the slurry wall would be constructed from the ground surface to the top of competent bedrock. Bedrock in Stream Valley A is a sandy shale of the Allegheny Group, which also forms the floor of the Ideal Mine. After regrading, the depth to bedrock would vary from about 45 feet below the surface at the western end of valley to about 30 feet in the area between Pond 1 and the landfill. Along the eastern side of the landfill the slurry wall would run north to south and would tie into the former face of the strip mine excavation where it would continue up along the sandstone and claystone that overlies the in-place coal. The overall average depth of the slurry wall would be about 40 feet.

The capital cost of this alternative is $ 15,455,900. The O&M cost is $ 245,000. The total present worth cost over a 30 year period considering an interest rate of 5% is $ 19,627,900. The time required to implement this alternative is 3 years. Key ARARs addressed with this alternative is Ohio closure requirements for landfills and the SDWA MCLs.

ALTERNATIVE NO. 7: GROUNDWATER EXTRACTION AND ON-SITE TREATMENT

This alternative is the same as Alternative 4, Multi-layer Cap, Groundwater Extraction and On-site Treatment, shown on Figure 14 except that a multi-layer cap and leachate collection system would not be installed. As with Alternative 2, Alternative 7 attempts to meet the remedial action objectives through institutional actions and monitoring with the added advantage of treating groundwater from the shallow aquifer.

The components of Alternative 7 are:

1. Institutional Controls
2. Site Fence
3. Alternate Water Supply
4. Monitoring
5. Surface Water Controls
6. Extraction Well System
7. On-site Water Treatment Plant
8. Discharge of Treated Water To Surface Water
9. Wetlands Replacement

Although this alternative meets the four remedial objectives discussed on page 16 of this section, this alternative does not address one key ARAR which is the Ohio landfill closure requirement.

ALTERNATIVE NO. 8: MULTI-LAYER RCRA CAP WITH UPGRADE OF THE BYESVILLE WATER TREATMENT PLANT.

Alternative 8 is the same as Alternative 3, Multi-layer RCRA Cap, with the addition of an upgrade to the Byesville Water Treatment Plant to prevent any contamination from the Fultz Landfill site that might migrate to the Byesville Plant No. 2 from entering the public drinking water supply. The upgrade to the Byesville Water Treatment Plant would consist of a well-head treatment system to treat site related contaminants. This Alternative achieves the remedial action objectives both by institutional controls and by insuring a safe drinking water supply regardless of increases in contaminant concentrations, if any, in the deeper coal mine aquifer.

The components of Alternative 8 are:

1. Institutional Controls
2. Site Fence
3. Alternate Water Supply
4. Monitoring
5. Subsurface Structural Supports
6. Surface Water Controls
7. Multi-layer Cap
8. Leachate Collection System
9. Upgrade of the Byesville Water Treatment Plant
10. Wetlands Replacement

This alternative meets the four remedial objectives discussed on page 16 of this section. However, it allows groundwater contamination to spread through approximately 1 mile of aquifer before being treated at the Byesville Water Treatment Plant. It is USEPA policy to intercept and collect contaminated groundwater as close to the source as possible. By allowing contaminated groundwater to spread and treating it when it gets to the Byesville Water Treatment Plant, a large portion of the aquifer will become contaminated.

ALTERNATIVE NO. 9: ON-SITE LANDFILL WITH GROUNDWATER EXTRACTION AND TREATMENT

Alternative 9 is a combination of Alternative 5, On-site RCRA Landfill with the groundwater extraction and the on-site treatment system of Alternative 4. The array of groundwater extraction wells consists of 8 wells instead of the 12 wells used in Alternative 4. Only 8 wells would be used because the wells in Alternative 4 that were intended to cut off the migration of contaminants from the existing landfill to the coal mine aquifer would not be needed once the landfill waste is relocated. Alternative 9 meets the remedial action objectives in the same manner as Alternative 5 with the added benefit of extracting contaminated groundwater from the shallow aquifer for treatment.

The components of Alternative 9 are:

1. Institutional Controls
2. Site Fence
3. Alternate Water Supply
4. Monitoring
5. Surface Water Controls
6. Over-excavation of the Underground Mine
7. Rock Underdrain
8. Erosion and Sediment Controls
9. Dewatering Facilities
10. RCRA Equivalent On-site Landfill
11. Extraction Well System
12. On-site Water Treatment Plant
13. Discharge of Treated Water To Surface Water
14. Wetlands Replacement

Although this alternative meets the four remedial objectives discussed on page 16 of this section, this alternative does not address one key ARAR which is the Ohio landfill siting criteria.

ALTERNATIVE NO. 10: COAL MINE AQUIFER CUT-OFF BARRIER

Alternative 10 meets the remedial action objectives by a combination of the institutional actions of Alternative 2, and the installation of a low permeability barrier within the coal mine aquifer. The cut-off barrier would effectively prevent the migration of contaminants from the existing landfill and shallow aquifer into the coal mine aquifer.

The components of Alternative 10 are:

1. Institutional Controls
2. Site Fence
3. Alternate Water Supply
4. Monitoring
5. Erosion and Sediment Controls
6. Dewatering Facilities
7. Low Permeability Compacted Clay Cut-off Barrier
8. Surface Water Control
9. Wetlands Restoration

Institutional Controls, Site Fence, Alternate Water Supply, and Monitoring Items 1 through 4 of Alternative 2 would be performed. Item 9 as described in Alternative 3, would also be included with Alternative 10.

5. Erosion and Sediment Controls

Temporary erosion and sedimentation controls such as silt fences, hay-bail siltation barriers and small diversion channels would be installed as needed to prevent erosion during the construction of the cut-off barrier. Because the excavation and construction of the barrier can be staged to proceed from one end to the other, no permanent diversion channels or sediment ponds would be needed.

6. Dewatering Facilities

Temporary dewatering facilities consisting of well points and sump pumps would probably be required during the excavation of the trench for the cut-off barrier to control the seepage of groundwater into the excavation. A line of well points will be installed along sides of the excavation to lower the water table as needed during construction. Water that seeps into the excavation from the coal mine aquifer would be removed with sump pumps. Temporary facilities meeting all applicable Federal and State requirements would be built to hold the extracted water for testing and treatment or disposal.

7. Low Permeability Compacted Clay Cut-off Barrier

Construction of a 2,400-feet long cut-off barrier in the coal mine aquifer would begin with the excavation of a trench from the ground surface to the floor of the coal mine. The trench would be 20-feet wide at the bottom and from 50 to 180 feet wide at the ground surface. It would extend from the intact coal to the north of Stream Valley A through the former Ideal Mine, Stream Valley A between Pond 1A and Pond 1, through the former Ideal Mine west and south of the existing landfill to the intact coal on the northern side of Stream Valley B. The depth of the trench would vary from 36 feet near Stream A to 115 feet at the crest of the hill south of Pond 1. The average depth would be about 80 feet and would require the removal of an estimated 610,000 cubic yards of material approximately 60% of which would be rock. The trench would be filled with compacted clay to achieve a permeability of less than 10^{-7} cm/sec. The clay backfill would extend to within 3 feet of the original ground surface. The uppermost 3 feet of the excavation would be backfilled with random fill and covered with sufficient topsoil to permit revegetation of the disturbed area.

8. Surface Water Control

Part of the cut-off barrier would intersect Stream Valley A between Pond 1A and Pond 1. During the excavation and backfilling of the cut-off trench, Stream A would have to be temporarily re-routed around the excavation. To accomplish, the excavation would proceed in stages to allow Stream A to be diverted through a series of channels circumventing the excavation area.

Although this alternative meets the four remedial objectives discussed on page 16 of this section, this alternative does not address one key ARAR which is the Ohio landfill closure requirement.

SCREENING OF ALTERNATIVES

Alternatives were initially developed to be evaluated against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Alternatives were evaluated generally in the screening stage, then in more detail in the detailed analysis of alternatives. Of the 10 alternatives that were developed to meet the remedial action objectives, 4 were eliminated in the screening stage. Rationale for screening out Alternatives 7 through 10 is as follows.

ALTERNATIVE 7: GROUNDWATER EXTRACTION (WITHOUT CAP)

Alternative 7 was not carried forward for detailed analysis because, without the installation of a cap, it did not provide adequate closure of the existing landfill. It would be less effective in preventing the spread of contamination because it would not address the vertical migration of contaminants through the bedrock layer between the existing landfill and the coal mine aquifer. Although the cost would be much lower than Alternatives 3 through 6, the groundwater extraction system would need to be operated indefinitely because there would be no reduction in contaminant transport by infiltration of precipitation through the existing landfill.

ALTERNATIVE 8: CAP WITH UPGRADE OF THE BYESVILLE WATER TREATMENT PLANT.

Alternative 8 was not carried forward for detailed analysis because the analysis of contaminant transport from the Fultz Landfill site to the coal mine aquifer utilizing a two dimensional solute model indicated that the effects of the Fultz Landfill site on the Byesville water supply well are minimal at present but may be more significant in the future. This alternative allows groundwater contamination to spread through approximately 1 mile of aquifer before being treated at the Byesville Water Treatment Plant. As stated on page 26 of this section, contaminated groundwater should be intercepted and collected as close to the source as possible. The cost of remediation of 1 mile of contaminated aquifer in the future is much greater than the present cost of containing the contamination.

ALTERNATIVE 9: ON-SITE LANDFILL WITH GROUNDWATER EXTRACTION

Alternative 9 was not carried forward for detailed analysis because it would not be necessary to collect and treat groundwater once the source of contamination (the landfill) has been removed. Additionally, the construction on-site would not meet Ohio Solid Waste Landfill siting requirements. Although the cleanup time for the shallow aquifer would potentially be shorter with groundwater extraction and treatment, the additional expense of an extraction and treatment system is not justified. The cost of groundwater extraction and treatment would make Alternative 9 substantially higher than Alternative 5 - On-Site Landfill.

ALTERNATIVE 10: COAL MINE AQUIFER CUT-OFF BARRIER.

Alternative 10 would be the most effective alternative for preventing the off-site migration of contaminants from the Fultz Landfill site through the coal mine aquifer. However, the highest risks that were identified in the risk assessment were attributed to future use of on-site groundwater. Alternative 10 would address risks from use of the on-site groundwater with site access and use restrictions only, making it no more effective than Alternative 2 at reducing the highest risks. Although the technologies used to implement Alternative 10 are common and readily available, an excavation of this size involving the movement of 700,000 cubic yards of earth and rock and the importation of a near equal quantity of clay would be an enormous task. Controlling the infiltration of groundwater from the coal mine aquifer might also prove very difficult. Because it is not more effective in reducing the major risks at the Fultz Landfill site, would be costly and difficult to implement, and without the installation of a cap would not provide adequate closure of the existing landfill, Alternative 10 was not carried forward for detailed analysis.

VIII. Summary of Comparative Analysis of Alternatives

OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

This criterion addresses whether or not a remedy provides adequate protection, and describes how risks are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.

Alternative 1 does not eliminate, reduce or control the current and future potential risks to human health and the environment associated with the Fultz

Landfill. Alternative 2 does not reduce risks to the environment. All of the alternatives except 1 and 2 reduce the current and future potential risks to human health and environment associated with the Fultz Landfill.

COMPLIANCE WITH ARARS

This criteria addresses whether or not a remedy will meet all of the applicable or relevant and appropriate requirements (ARARs) of other environmental statutes and/or provide grounds for invoking a waiver. A waiver would be allowed only if the chosen remedy is considered to be an improvement over other remedies that do comply with ARARs. ARARS are divided into action, location, and chemical specific categories.

1. Action specific ARARs are requirements that set controls or restrictions on design, implementation, and performance levels of activities related to the management of hazardous substances, pollutants, or contaminants.

2. Location specific ARARs are requirements that restrict remedial actions based on the location or characteristics of the site or its immediate environs.

3. Chemical specific ARARs are requirements that set protective cleanup levels for chemicals of concern, or are used to indicate an acceptable limit of discharge associated with a remedial action.

Alternative 2, Institutional Actions and Monitoring, does not meet ARARs for the Fultz Landfill site. ARARs not addressed by this alternative are: closure of the existing landfill according to state standards; MCLs would be exceeded in the shallow or deep mine aquifers for lead, antimony, beryllium, and vinyl chloride; and maximum leachate concentrations would continue to exceed surface water criteria for discharges to Wills Creek for at least four organic and inorganic compounds. Alternative 5 does not meet ARARs because it does not meet State of Ohio solid waste landfill siting criteria. Alternatives 3, 4 and 6 would meet all Federal and State environmental requirements. Since Alternatives 2 and 5 failed to meet this criteria they will be eliminated from further consideration. Alternatives 3, 4 and 6 will be carried forward in the comparison.

LONG-TERM EFFECTIVENESS AND PERMANENCE

Long-term effectiveness refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals have been met.

The reduction in long-term effectiveness of each of the alternatives depends in part on the enforcement of institutional controls. Alternative 4, provides an advantage over alternatives 3 and 6 because contaminated groundwater is extracted and treated. By removing contaminated groundwater alternative 4 provides for a greater degree of permanence in groundwater cleanup. Alternative 4 also provides hydraulic containment of contaminants from the existing landfill. By not allowing groundwater contamination to spread, alternative 4 also provides a greater degree of long-term effectiveness. Alternative 6 provides a partial barrier to contaminant migration. Alternative 3 provides only control over infiltration induced migration of contaminants. Listed in the order of overall long-term effectiveness from the most effective to the least effective; they are:

Most Long-Term Effective
- Alternative No. 4: Multi-layer Cap with Groundwater Treatment
- Alternative No. 6: Multi-layer Cap with Subsurface Barrier
- Alternative No. 3: Multi-layer Cap

Least Long-Term Effective

REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT

Reduction of toxicity, mobility, or volume refers to the anticipated performance of the treatment technologies employed under each remedy.

Alternative 4 provides the greatest reduction in toxicity and volume of hazardous materials. Alternative 4 achieves the same reduction in mobility and toxicity as Alternative 3 plus an additional 6 million gallons of contaminated groundwater per year would be extracted and treated. Based on the HELP model, over a 25 year period, an estimated 526,000 gallons per year of leachate would be collected and treated on site. The on-site treatment of groundwater and leachate would produce residuals in the form of metal contaminated sludges. Listed in the order of overall reduction of toxicity, mobility and volume through treatment from the greatest reduction to the least reduction, they are:

Greatest Reduction
- Alternative No. 4: Multi-layer Cap with Groundwater Treatment
- Alternative No. 6: Multi-layer Cap with Subsurface Barrier
- Alternative No. 3: Multi-layer Cap

Least Reduction

SHORT-TERM EFFECTIVENESS

Short-term effectiveness involves the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period until cleanup goals are achieved.

Alternative 4 achieves remedial action goals in an estimated range of 4-14 years. Alternatives 3 and 6 are estimated to achieve remedial action goals between 13-46 years. Although alternative 4 requires a somewhat longer time for construction, it is estimated to achieve remedial action goals in the least amount of time. Alternative 6 poses the greatest risk to workers during construction because of the excavation of the slurry wall. Releases of airborne contaminants could occur during the excavation operation. Alternatives 3 and 6 pose a greater risk to the community because leachate will be hauled off-site. Listed in the order of short-term effectiveness in achieving remedial action goals from the most effective to the least-effective, they are:

Most effective in the short term
- Alternative No. 4: Multi-layer Cap with Groundwater Treatment
- Alternative No. 3: Multi-layer Cap
- Alternative No. 6: Multi-layer Cap with Subsurface Barrier

Least effective in the short term

IMPLEMENTABILITY

Implementability refers to the technical and administrative feasibility of a remedy, including the availability of goods and services needed to implement the chosen remedy.

Implementation of institutional controls listed under each alternative being evaluated and the ease of implementation is to some degree dependant upon public acceptance. All of the alternatives are relatively easy to implement, use widely available equipment and materials, and well established reliable methods. Installation of the slurry wall of Alternative 6 in the strip mine spoil of Stream Valley A may be difficult because of the nature of strip mine spoil. A detailed design investigation would have to be performed to assure that a slurry wall will be cost effective and practical to implement. Alternative 4 would be less difficult than Alternative 6, but would be more difficult to implement than Alternative 3 because well installation would require a detailed design investigation in order to determine the optimum well placement and pumping rates. Alternative 4 will require the off-site disposal of water treatment residuals. Based on the above discussion, Alternative 3 would be the easiest to implement. Listed in the order of overall ease of implementation from the easiest to implement to the most difficult to implement, they are:

Easiest to implement
  Alternative No. 3: Multi-layer Cap
  Alternative No. 4: Multi-layer Cap with Groundwater Treatment
  Alternative No. 6: Multi-layer Cap with Subsurface Barrier
Most difficult to implement

COST

Cost criteria includes capital cost, operation and maintenance cost, and present worth cost which includes capital and O & M costs.

All of the alternatives have about the same total implementation cost. Alternative 3 has the lowest capital cost but projected operating costs are higher than Alternative 4 due to the cost of off-site leachate disposal. Alternative 6 also has a substantial cost associated with off-site disposal of leachate. Listed in order of least costly to most costly; they are

Least costly
  Alternative No. 3: Multi-layer Cap $ 18,906,900
  Alternative No. 6: Multi-layer Cap & Subsurface Barrier $ 19,627,900
  Alternative No. 4: Multi-layer Cap & Groundwater Treatment $ 19,480,700
Most costly

STATE ACCEPTANCE

State acceptance includes whether, based on its review of the RI/FS and Proposed Plan, the state agency (OEPA) concurs, opposes, or has no comment on the preferred alternative.

USEPA has involved the OEPA in the RI/FS and remedy selection process. OEPA was provided the opportunity to comment on the RI/FS documents and the Proposed Plan, and took part in the Proposed Plan public meeting held in Byesville, Ohio on July 11, 1991. The State of Ohio has indicated that it concurs on the chosen remedial alternative. A letter from the OEPA indicates this support. See Attachment 1.

COMMUNITY ACCEPTANCE

Community acceptance is assessed in the Record of Decision following a review of the public comments received on the RI/FS and the Proposed Plan.

USEPA solicited input from the community on the remedial alternatives presented in the Proposed Plan for the Fultz Landfill site. Verbal comments received during the public meeting indicated support of the chosen remedial alternative. Two written comments were received and are addressed in the responsiveness summary. See Attachement 2.

IX. Selected Remedy

After reviewing each remedial alternative developed for the Fultz Landfill site, and comparing the alternatives against USEPA evaluation criteria, the USEPA recommends Alternative 4 - Multi-layer Cap, Groundwater extraction and on-site treatment, for addressing contamination problems at the site. Alternative 4 meets the four remedial action objectives discussed in Section 7 of this Record of Decision.

The components of Alternative 4 are:

1. Institutional controls will be sought to reduce exposure to site contaminants by legally restricting access to the site. Deed restrictions on land and water use on and adjacent to the landfill would be sought from the landfill owner and near by residents. A public information program to advise nearby residents of the nature of the problem at the site would be established. The USEPA would request local municipalities to enact local and zoning ordinances that will forbid future use of the site that would expose humans to contamination, and restricting the drilling of wells and the use of groundwater and surface water.

In the event that institutional controls are not voluntarily obtained, the selected remedial action may be re-evaluated to determine if additional actions should be implemented to ensure that the remedy is permanent and effective on a long term basis.

2. A 6-foot high chain-link fence approximately 10,000 feet in length, will be installed around the entire Fultz Landfill site to restrict access and reduce direct exposure to surface contamination. The fence will be topped with barbed wire and equipped with warning signs posted at 100-foot intervals along the fence.

3. Alternate Water Supply

A water supply inventory will be conducted to identify all residential wells that are downgradient and affected from the Fultz Landfill site. A sample would be taken from each well and analyzed using analytical methods appropriate to characterize water intended for drinking. Residences with wells that are found to present an unacceptable risk due to contamination from the Fultz Landfill will be connected to the municipal water supply.

4. Monitoring

Long-term monitoring of surface water, groundwater, combustible gas and sediments will be performed in accordance with applicable Ohio regulations for a minimum of 30 years to evaluate the migration of contaminants from the landfill and to monitor the effectiveness of the remedy. The actual monitoring plan would be determined during remedial design.

5. Subsurface Structural Supports will be constructed for the mine voids under the landfill to prevent damage of the cap by subsequent mine subsidence and to reduce the potential for bedrock fracturing between the landfill and the coal mine aquifer. There are two standard approaches to providing subsidence supports, namely, grout pillars and mine flushing. As indicated in the proposed plan, the grout pillar method is the preferred method to prevent subsidence.

6. Surface Water and Sediment Controls

Part of Stream Valley A northeast of the existing landfill will be regraded to eliminate standing surface water, and divert runoff away from the landfill. This will include filling in Ponds 2, 2A, and 3 and constructing a clean water diversion channel in the approximate location of Stream A from the western end of Pond 1 to the culvert downstream of Pond 6 to divert runoff away from the landfill. In order to provide sediment control for earth disturbances resulting from capping the landfill, a sediment control pond would be constructed in an area to the northwest of Pond 6.

7. Multi-layer Cap

A berm will be constructed of compacted clay along the northern side of the landfill to bring the toe of the cap up to elevation 835 feet MSL and reduce the overall slope of the cap to about 5-1/2%. A stability analysis will be performed on the proposed cap and berm. The results will be utilized in the remedial design. In accordance with OAC chapter 3745-27-11(G)(1)(c) the slope of the cap may be increased to no more than 25% if necessary to accommodate a stable berm. The above engineering stability analysis will determine the optimal cap and berm slopes for long-term stability. The analysis will also determine the effect of increasing the slope of the cap on the stability of the liner and the possibility for using a liner specifically designed for increased slopes. After constructing the containment berm, a multi-layer cap would be installed over the entire 30 acres of the landfill.

A detailed schematic of the multi-layer cap is presented in Figure 11. Cap layers would include (from the bottom up):

- Random earth fill required in places to grade off the existing landfill and establish an even slope of 5-1/2%;
- A synthetic drainage layer for gas collection with filter fabric above and below;
- A 24-inch thick compacted clay layer (10-7 cm/s permeability);
- A 40-mil HDPE synthetic liner;
- A synthetic drainage layer for infiltration with filter fabric above;
- A 30-inch thick random earth fill;
- A 6-inch thick topsoil layer.

8. Leachate Collection System

The leachate collection system will be installed along the northern side of the landfill to intercept groundwater leaving the landfill. A rock drain will be sloped to a central sump from which the accumulated leachate can be pumped for on-site treatment.

9. Extraction Well System

An array of extraction wells will be installed in the shallow aquifer to; 1) lower the water table in the landfill area, 2) intercept and hydraulically contain groundwater migrating into the deep-mine aquifer, and 3) collect contaminated groundwater for treatment thereby reducing the volume of hazardous liquids on site. The actual amount, location, and pumping rates for the extraction wells will be determined during the pre-design phase.

10. On-site Water Treatment Plant

An on-site water treatment plant will be installed which will reduce the contaminant levels sufficiently for discharge to surface water. If sludge produced from the on-site treatment system is found to be hazardous it will be disposed of in accordance with applicable Federal Land Disposal Restrictions. If the sludge is found to be non-hazardous, it still will be disposed of in an approved manner. The on-site water treatment system that is being considered for remediation of leachate and groundwater at the Fultz Landfill consists of the following processes:

- Oxidation
- Precipitation
- Filtration
- Carbon Adsorption

The final treatment system selection will be based on samples from the extraction system, after it is constructed and functioning. A bench scale treatability study would be conducted to determine the most efficient manner to treat contaminated leachate and groundwater.

11. Discharge of Treated Water To Surface Water

Discharge of the treatment plant effluent will be to Stream A downstream of the sediment pond by way of a dedicated discharge pipeline. The discharge of treatment plant effluent will be in accordance with substantive requirements of Ohio Revised Code (ORC) Chapter 6111, the National Pollutant Elimination System (NPDES) and Section 402 of the Clean Water Act (CWA).

12. Wetlands Replacement

Since the disturbance of wetland environment is anticipated from proposed remedial activities a study will be performed to delineate the extent of wetlands and develop a plan for remediation. At a minimum, the wetlands replacement plan will include replacement or restoration of the ponds and surrounding habitat. Upon completion of construction, the clean water diversion channel will be re-routed into the sediment pond, and the base water level of the sediment pond would be raised to provide pond surface area equal to the area lost by the elimination of Ponds 2 and 3 and the lowering of the pool level of Pond 1. Every attempt will be made to provide a minimum 1 to 1 wetlands mitigation.

Points of Compliance

Points of compliance for risks being addressed by the remedial action are:

1. Shallow aquifer groundwater at or beyond the edge of the waste management area.

2. Surface water in Stream A, after the sedimentation pond, prior to the confluence of Stream A and Wills Creek.

1. <u>Remediation Goals for the Shallow Aquifer</u>

  - Concentrations of site-related contaminants that also appear in background, shall be reduced to their respective background (upgradient) concentrations.

  - In addition, site-related contaminants <u>not detected in background (upgradient) wells</u> with an existing maximum contaminant level (MCL) shall be reduced to a concentration level at or below the MCL. The contaminants found on site above MCLs are vinyl chloride, antimony, beryllium, and lead.

  - Concentrations of carcinogenic site-related contaminants <u>not detected in background (upgradient) wells</u> shall be reduced to levels that pose a cumulative carcinogenic risk no greater than 1x10-6.

  - Concentrations of non-carcinogenic site-related contaminants <u>not detected in background (upgradient) wells</u> shall be reduced to levels that pose a cumulative hazard index no greater than one.

If it is determined, based on the preceding criteria and the system performance data over a 15 year period, that the above remediation goals for the shallow aquifer cannot be achieved, all of the following measures involving long-term management may occur, as a modification of the existing extraction well system:

1. low level pumping will be implemented as a long-term containment measure;

2. chemical-specific ARARs may require a review based on the technical

impractibility of achieving further contaminant reduction; and/or

3. institutional controls would be sought to restrict access to those portions of the aquifer which remain above MCLs or health-based goals, should this aquifer be proposed for use as a drinking water source.

2. Remediation Goals for Surface Water from Stream A

Under the proposed monitoring program, quarterly monitoring of surface water shall be performed at 2 locations in Wills Creek and two locations in Stream A. Sampling locations on Stream A should be prior to the confluence of Stream A and Wills Creek. The purpose of this sampling and analysis would be to monitor the levels of contaminants in Stream A, and Wills Creek resulting from the discharge of the shallow and coal mine aquifers. Ohio Water Quality Standards under the Ohio Administrative Codes 3745-01 (-03,-04,-05, and -07) shall be used to determine if the level of contamination from the site is acceptable.

Discharge from the treated leachate and groundwater from the on-site treatment plant to Stream A shall be in accordance with substantive requirements of Ohio Revised Code (ORC) Chapter 6111, the National Pollutant Elimination System (NPDES) and Section 402 of the Clean Water Act (CWA).

3. Costs

A complete summary of capital costs, operation and maintenance (O&M) costs and a present worth value cost over a 30 year period at a 5% and 10% interest rate, is presented in Table 32. The costs presented in this table assume the grout pillar method will be used to prevent subsidence on site. The capital cost of this alternative is $ 15,759,700. The O&M cost is $ 218,000. The total present worth cost over a 30 year period considering an interest rate of 5% is $ 19,480,700.

X. Statutory Determinations

The following is a brief description of how the selected remedy meets the statutory requirements of Section 121 of CERCLA.

Protection of Human Health and the Environment.

Current and potential future risks to human health and the environment from contaminated groundwater (shallow and deep aquifers), leachate and air would be reduced provided that the cap remains intact, hydraulic containment and extraction of groundwater and leachate is obtained, and site access and use restrictions are strictly enforced. The bulk of the contamination source (solid wastes and hazardous liquid wastes) would remain on-site, but the mobility and volume would be reduced by the cap, leachate collection system, and active groundwater containment and extraction from the shallow aquifer. The selected remedy will attain a 10^{-4} to 10^{-6} risk level for carcinogens and a Hazardous Index <1 for noncarcinogens. No unacceptable short-term risks or cross-media impacts will be caused by implementation of the selected remedy.

Compliance with Applicable or Relevant and Appropriate Requirements.

Applicable action-specific ARARs for landfill closure (OAC 3745-27-10), would be complied with by installation of a RCRA Subtitle C cap. RCRA Land Disposal Restrictions (40 CFR 268) regarding treatment residuals and Department of Transportation (49 CFR Parts 100-199) involving transport of waste off site, would be complied with, if the treatment plant sludge is found to be hazardous. Substantive requirements of a (40 CFR 122,125) NPDES discharge permit regarding discharge of treated water to a surface water body would be complied with. SDWA (40 CFR 144) Underground Injection Control Program (UIC) requirements regarding standards for the underground injection of fluids (cement used for grout pillars) would be complied with. Executive Order 1990 (40 CFR 6, Appendix A) regarding wetlands would be complied with.

Applicable chemical-specific ARARs (SWDA MCLs) for concentrations of antimony, beryllium, lead, and vinyl chloride found in groundwater, at the point of compliance, would be complied with by returning concentrations of contaminants to their respective MCLs. If naturally occurring concentrations of contaminants exceed their respective MCLs, attainment of their MCLs would not be applicable or relevant and appropriate pursuant to USEPA policy. Contaminants found naturally occurring, above acceptable health-based levels, will be return to their naturally occurring concentration. Anthropogenic contaminants without MCLs, found above acceptable health-based levels will be return to their acceptable health-based level.

<u>Cost-Effectiveness</u>.

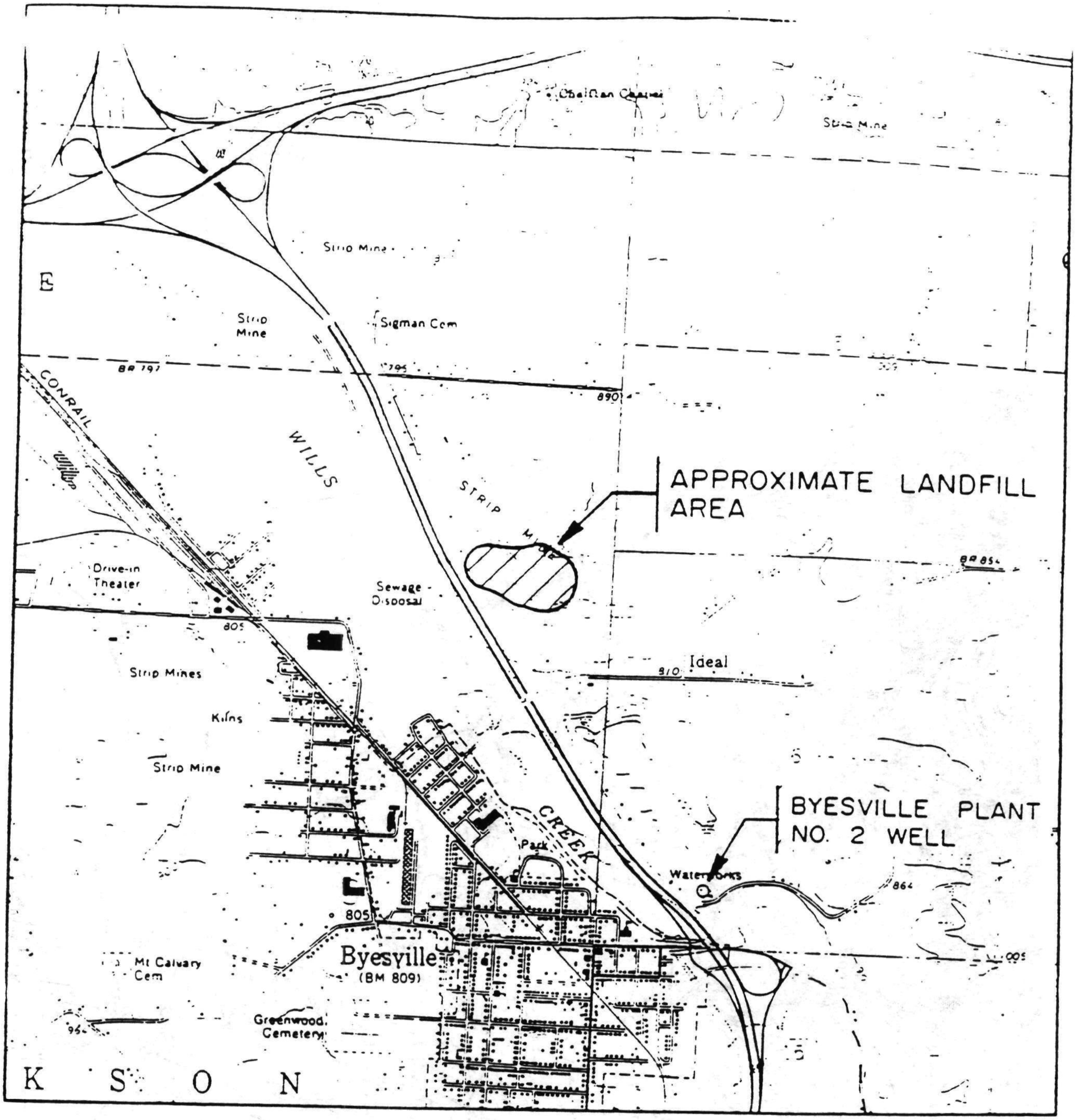
The USEPA believes the selected remedy complies with ARARs and is cost-effective in mitigating the principal risk posed by contaminated groundwater and leachate within a reasonable period of time. Section 300.430(f)(ii)(D) of the NCP requires USEPA to assess cost-effectiveness by evaluating all alternatives which satisfy the threshold criteria: protection of human health and the environment and compliance with ARARs, with three additional balancing criteria: long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, and short-tern effectiveness, to determine overall cost-effectiveness. The selected remedy meets these criteria and provides for overall effectiveness in proportion to its cost. The estimated cost for the selected remedy is $ 19,480,700.

<u>Utilization of Permanent Solutions and Alternative Treatment (or resource recovery) Technologies to the Maximum Extent Practicable (MEP)</u>.

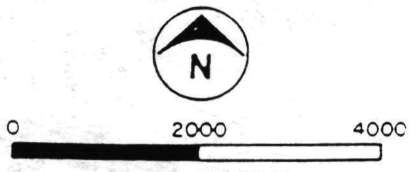
USEPA believes the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the Fultz Landfill site. Of those alternatives that are protective of human health and the environment and comply with ARARs, the USEPA has determined that the selected remedy provides the best balance of trade-offs in terms of long-term effectiveness and permanence; reduction of toxicity, mobility, and volume achieved through treatment; short-term effectiveness; implementability; and cost. The selected remedy also meets the statutory preference for treatment as a principal element and considering State and community acceptance.

<u>Preference for Treatment as a Principal Element.</u>

The selected remedy satisfies, to the maximum extent practicable, the statutory preference for treatment as a principal element. The principal threat to human health is ingestion of contaminated groundwater from the either the shallow aquifer or the deeper coal mine aquifer. The selected remedy reduces levels of organic and inorganic contaminant concentrations present in groundwater by using an oxidation, precipitation, filtration, and carbon adsorption, treatment plant.

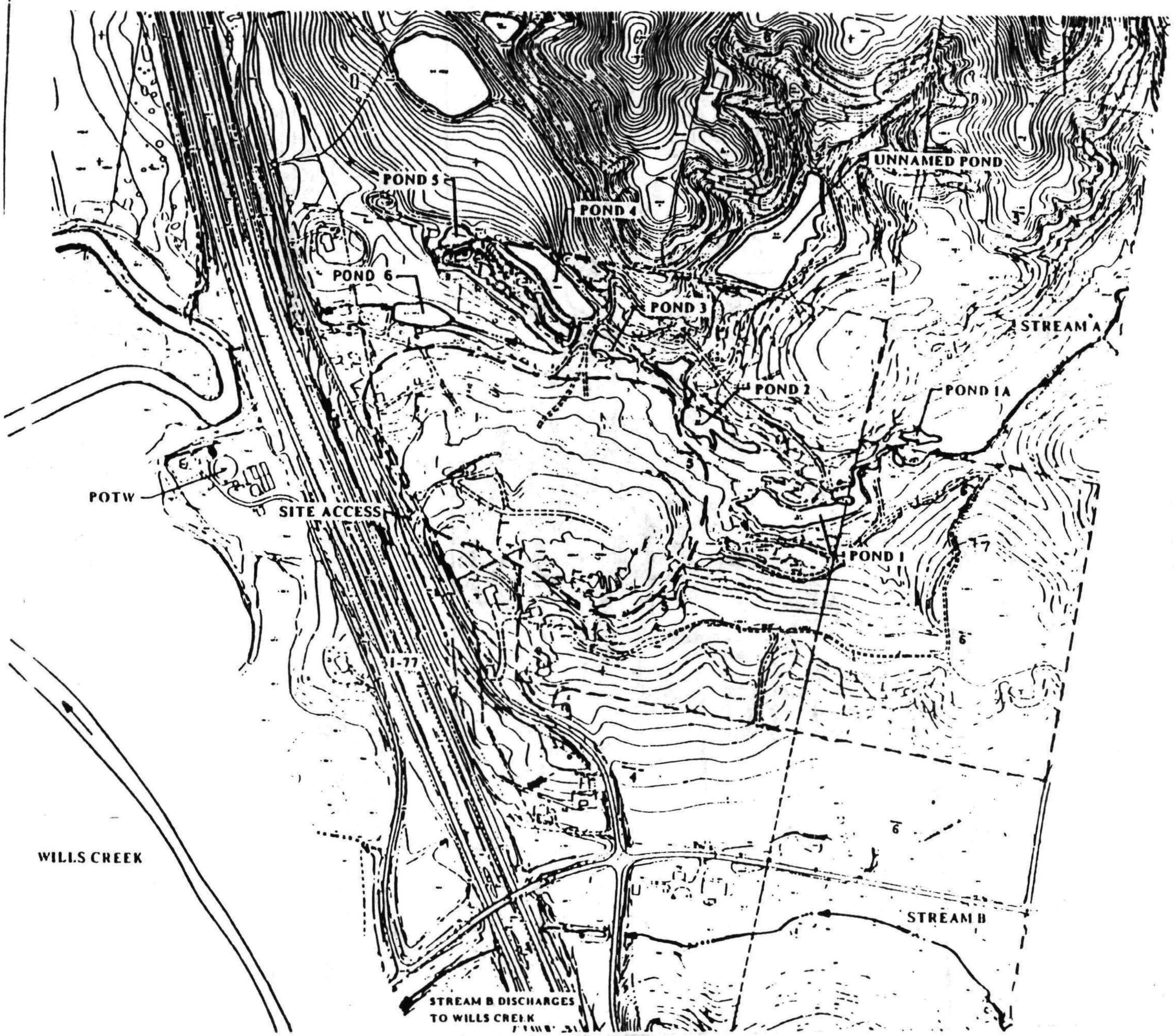


REFERENCE:
USGS 7.5' TOPOGRAPHIC MAPS, BYESVILLE QUADRANGLE, OHIO, DATED 1961, PHOTOREVISED 1972 AND 1975, CAMBRIDGE QUADRANGLE, OHIO, DATED 1962, PHOTOREVISED 1972 AND 1978, SCALE 1" = 2000'



POOR QUALITY ORIGINAL

FIGURE 1
SITE LOCATION MAP
FULTZ LANDFILL SITE, BYESVILLE, OH
RI REPORT



LEGEND

APPROXIMATE LANDFILL A A

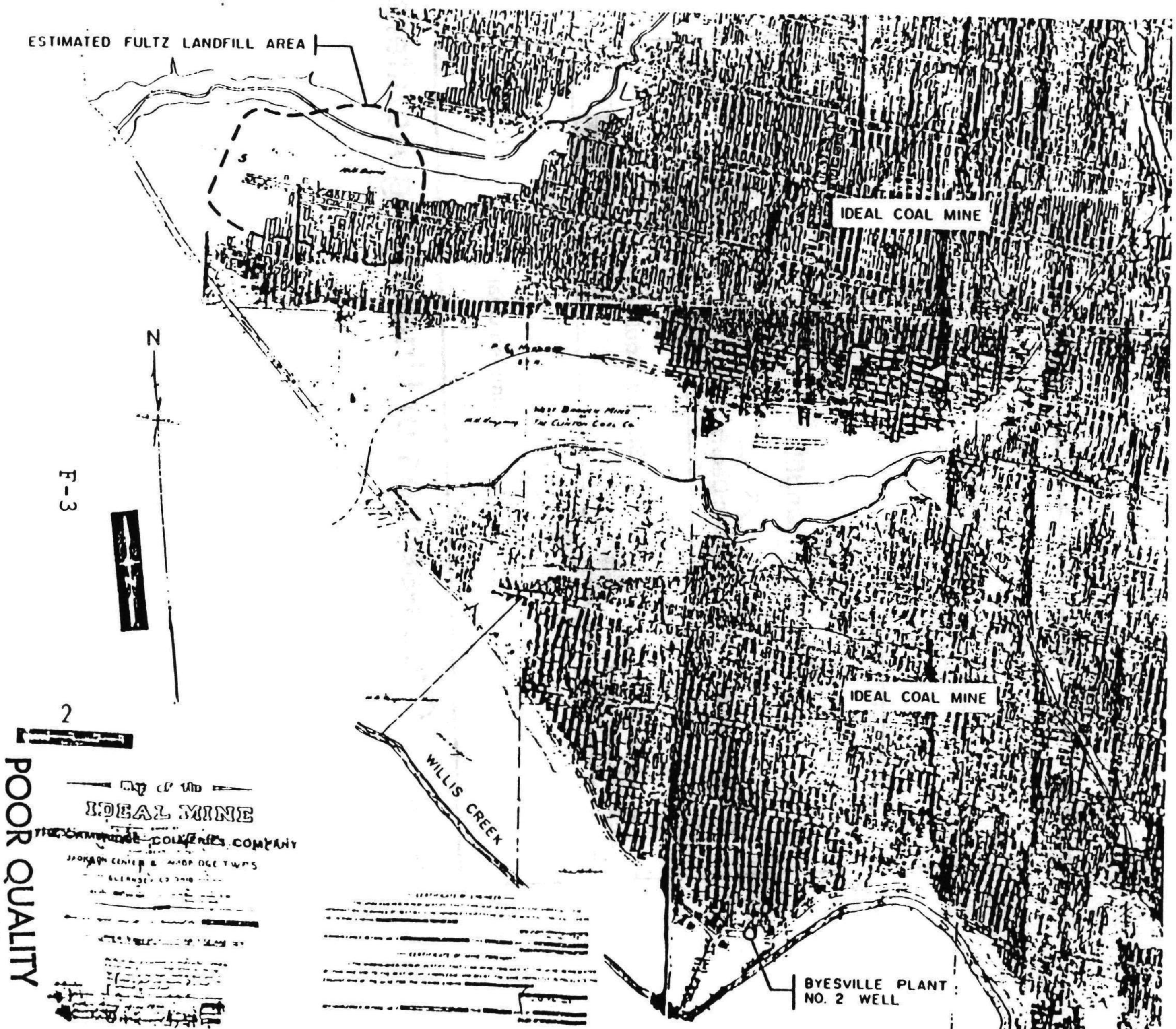
PROPERTY BOUNDARY

POTW PUBLICLY OWNED TREATMENT FOR CITY OF BYESVILLE

0 400

SCALE IN FEET

FIGURE 2
SITE MAP
FULTZ LANDFILL SITE, BYESVILLE
RI REPORT



F-3

POOR QUALITY ORIGINAL

SOURCE U.S. Bureau of Mines, Mine Map ... Pittsburgh, PA

NOTE This image is the best available reproduction of the Ideal Mine, a ... in the Upper Freeport Coal seam ... image is presented to illustrate the ... complexity of the mining pattern a... passage ways. The accuracy of t... map cannot be confirmed.

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SCALE IN FEET
APPROXIMATE

FIGURE 3
IDEAL COAL MINE
FULTZ LANDFILL SITE, BYESVI...
RI REPORT

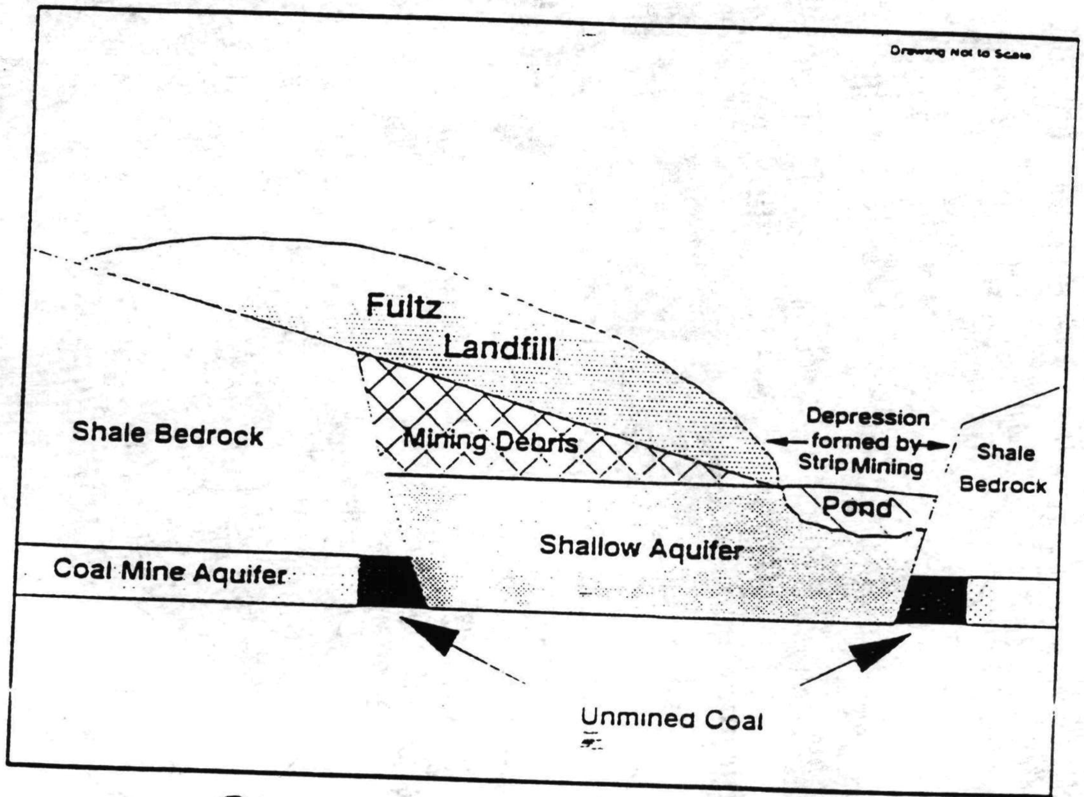


Figure 4 **Cross-section of Underlying Aquifers**

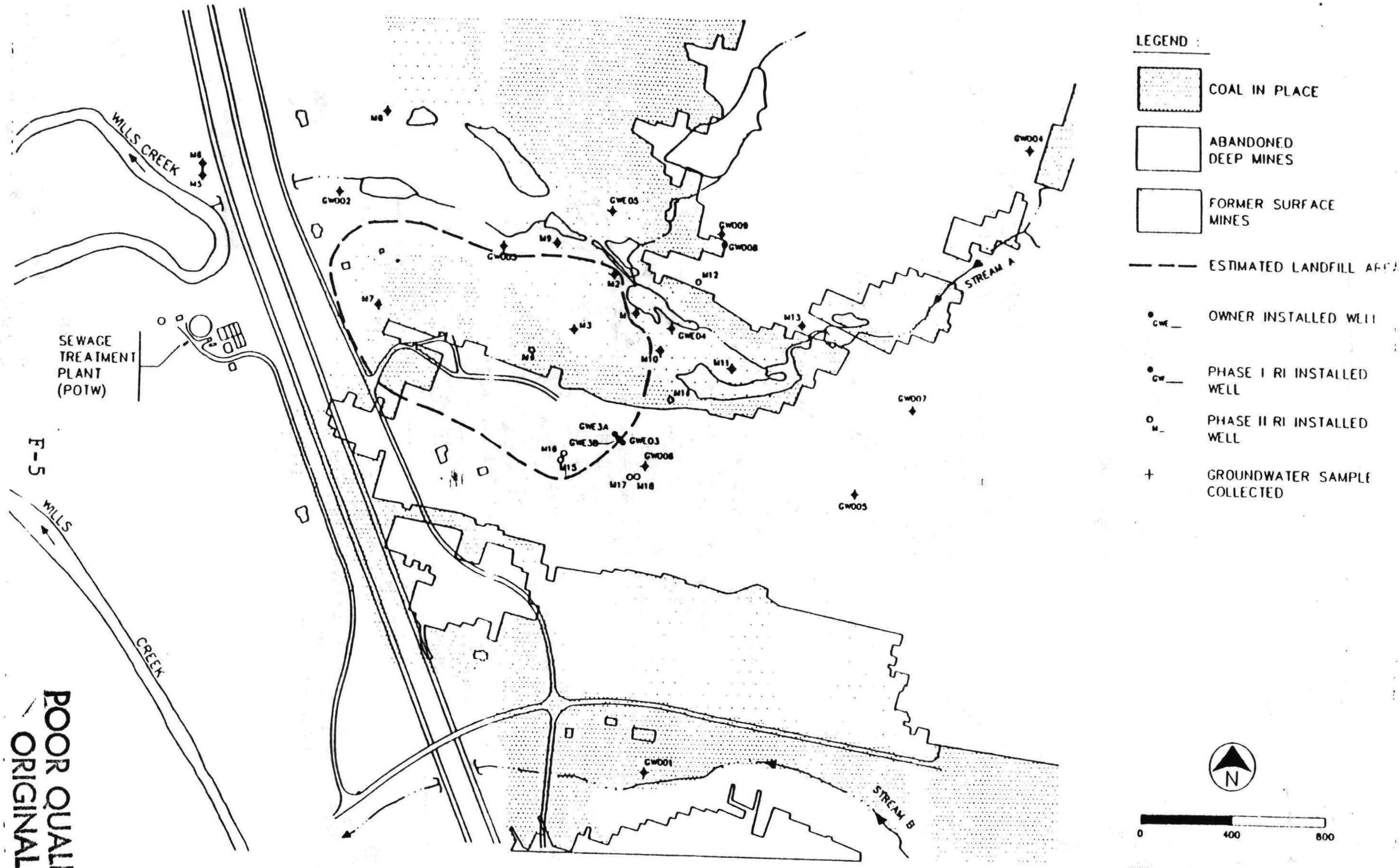
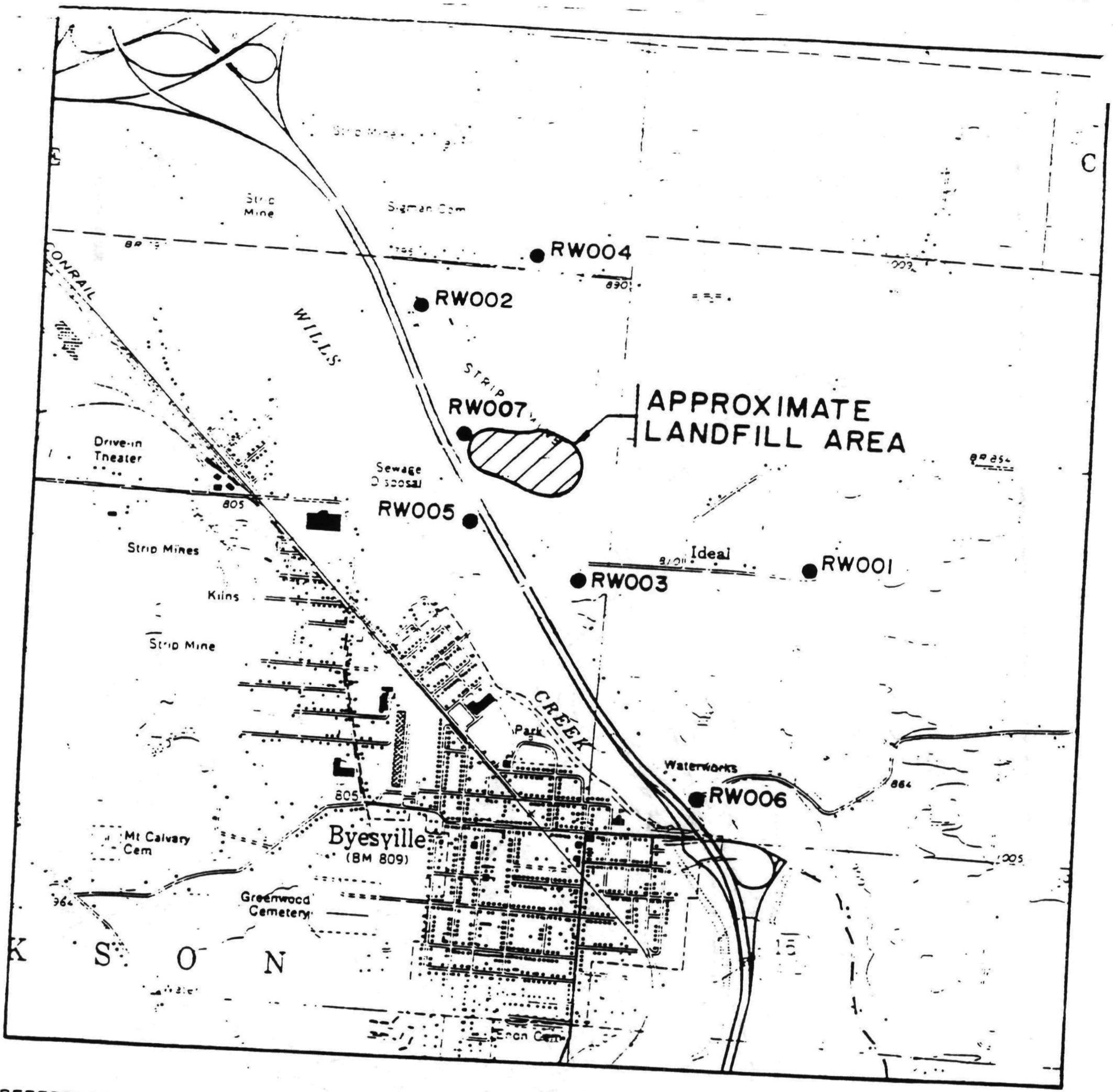


FIGURE 5
MONITORING WELL LOCATIONS
FULTZ LANDFILL SITE, BYESVILLE, OH
RI REPORT

F-5

POOR QUALITY ORIGINAL



REFERENCE:

U.S.G.S. 7.5' TOPOGRAPHIC MAP, BYESVILLE QUADRANGLE, OHIO, DATED: 1961
PHOTOREVISED: 1972 & 1975, SCALE: 1"=2000'

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FIGURE 6
RESIDENTIAL WELL SAMPLING LOCATIONS
FULTZ LANDFILL SITE, BYESVILLE, OH
RI REPORT

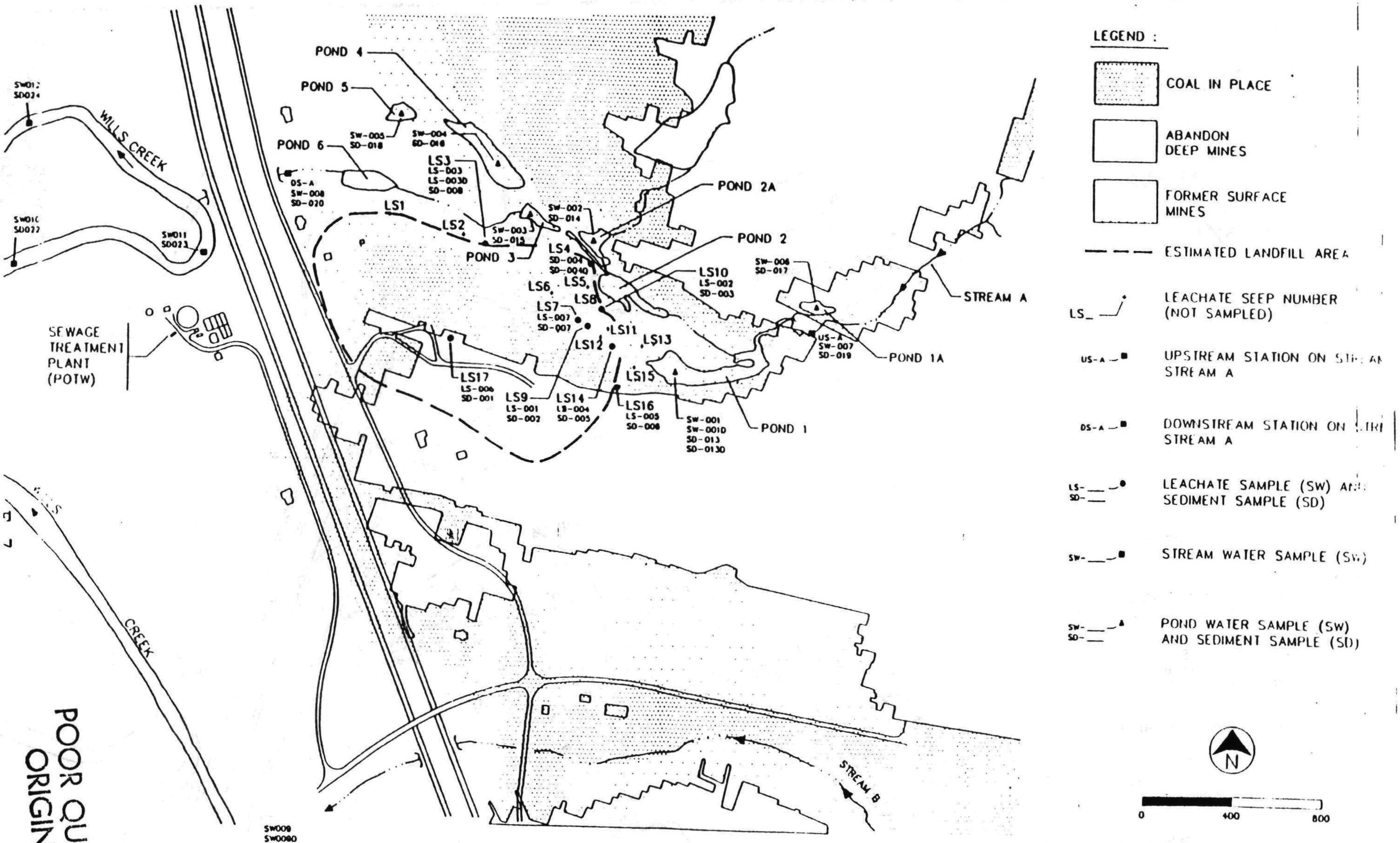

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FIGURE 7
SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS
FULTZ LANDFILL SITE, BYESVILLE, OH
RI REPORT

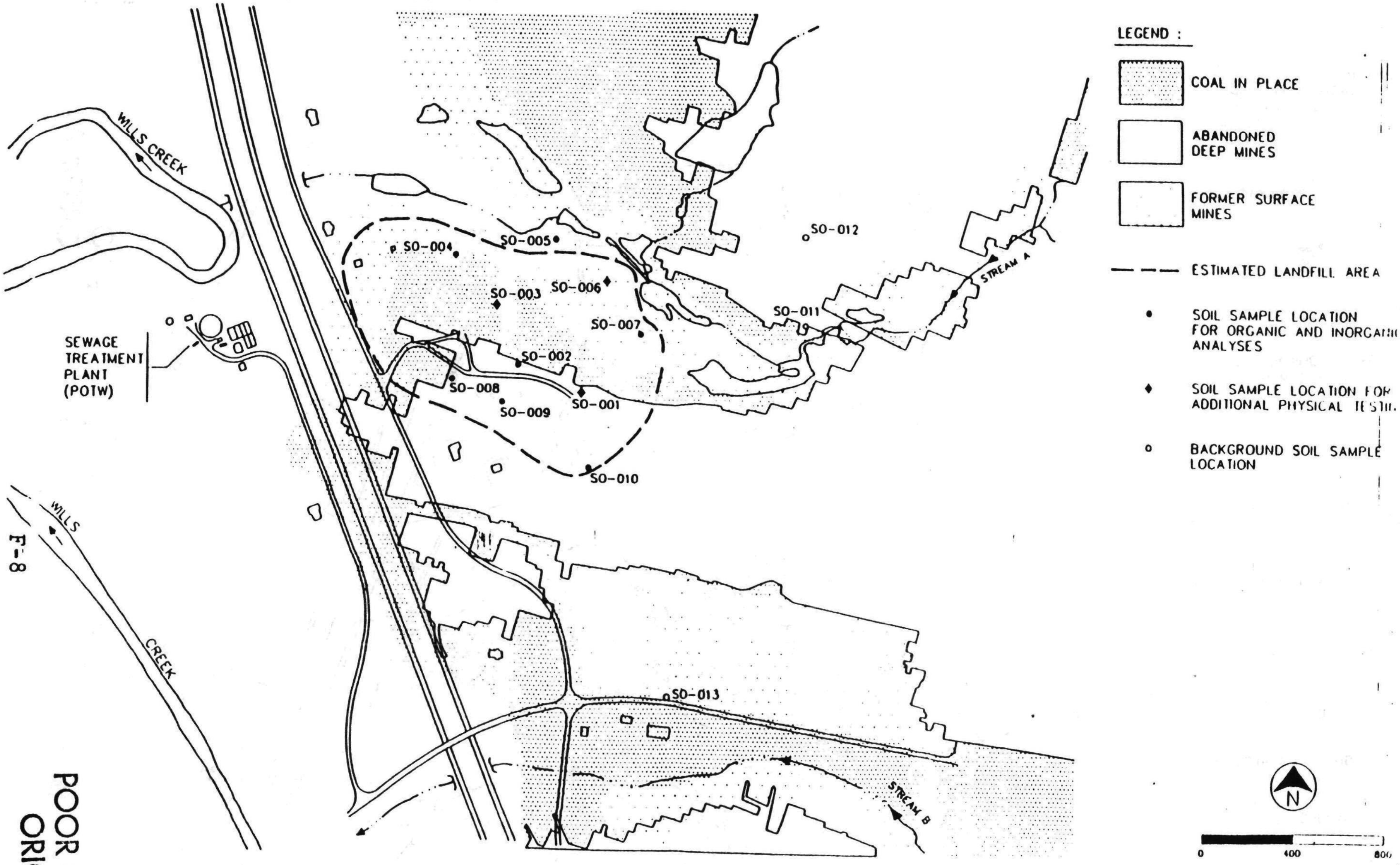
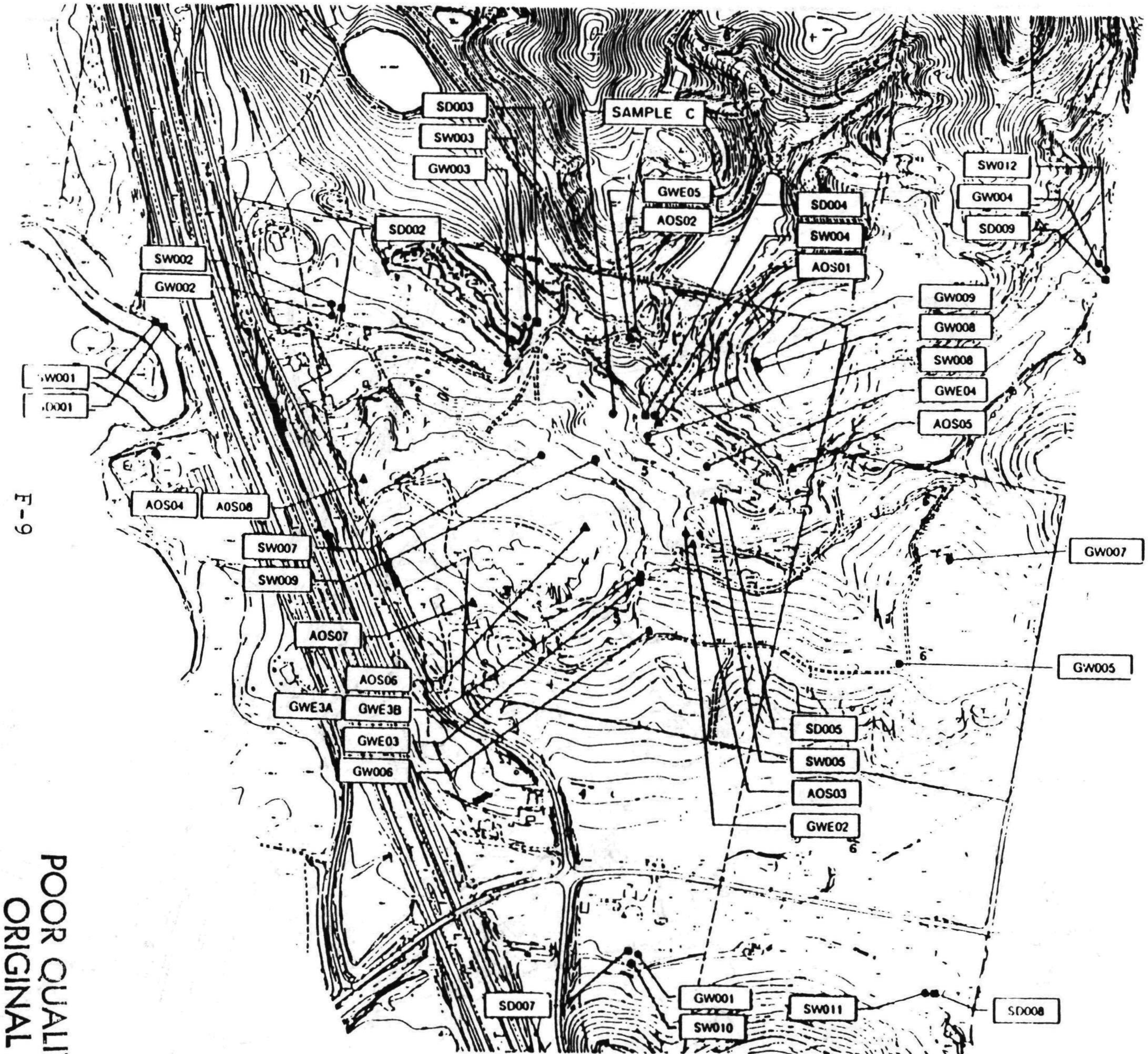


FIGURE 8
SURFACE SOIL SAMPLE LOCATIONS
FULTZ LANDFILL SITE, BYESVILLE, OH
RI REPORT



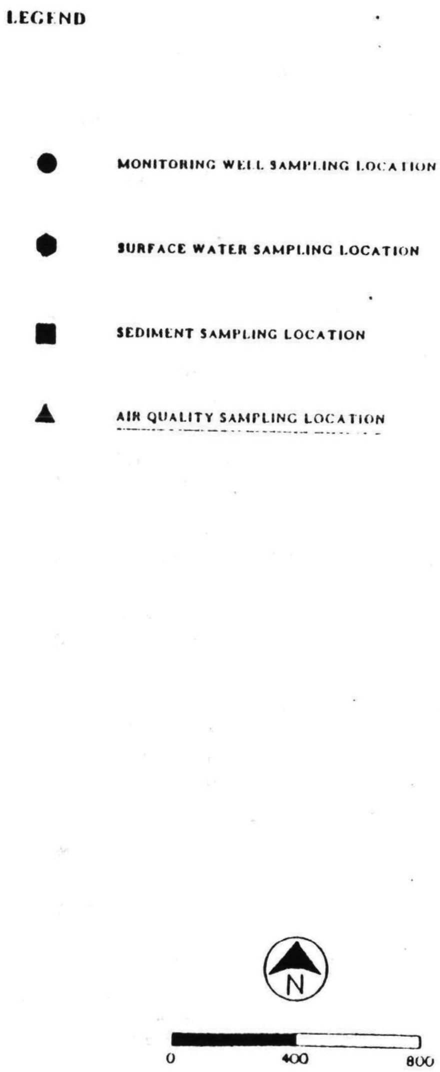


FIGURE 9
PHASE I RI SAMPLING LOCATIONS
FULTZ LANDFILL SITE, BYESVILLE, OH
RI REPORT

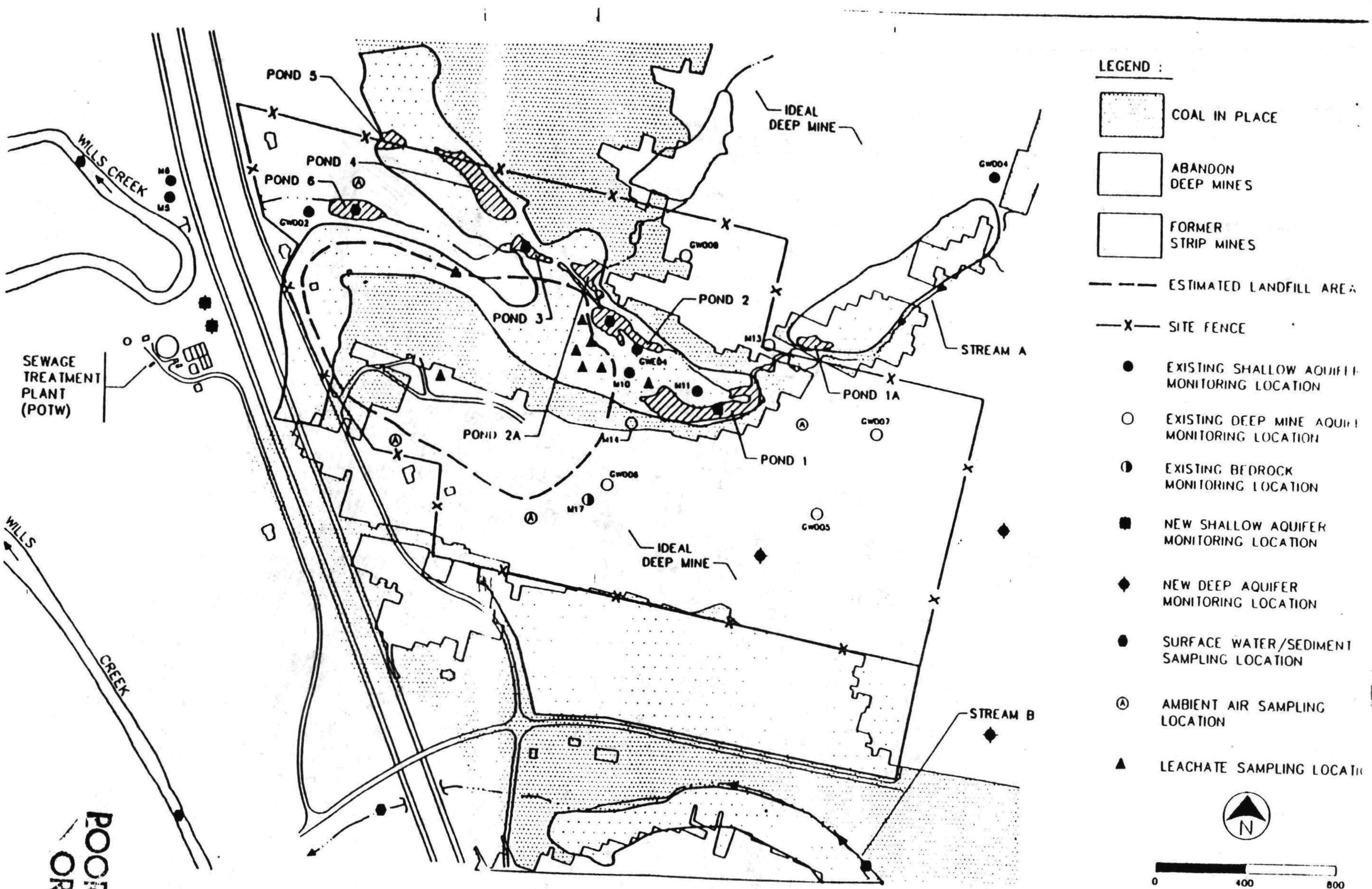


FIGURE 10
ALTERNATIVE 2
INSTITUTIONAL ACTIONS
AND MONITORING
FULTZ LANDFILL SITE,
FEASIBILITY STUDY REPORT

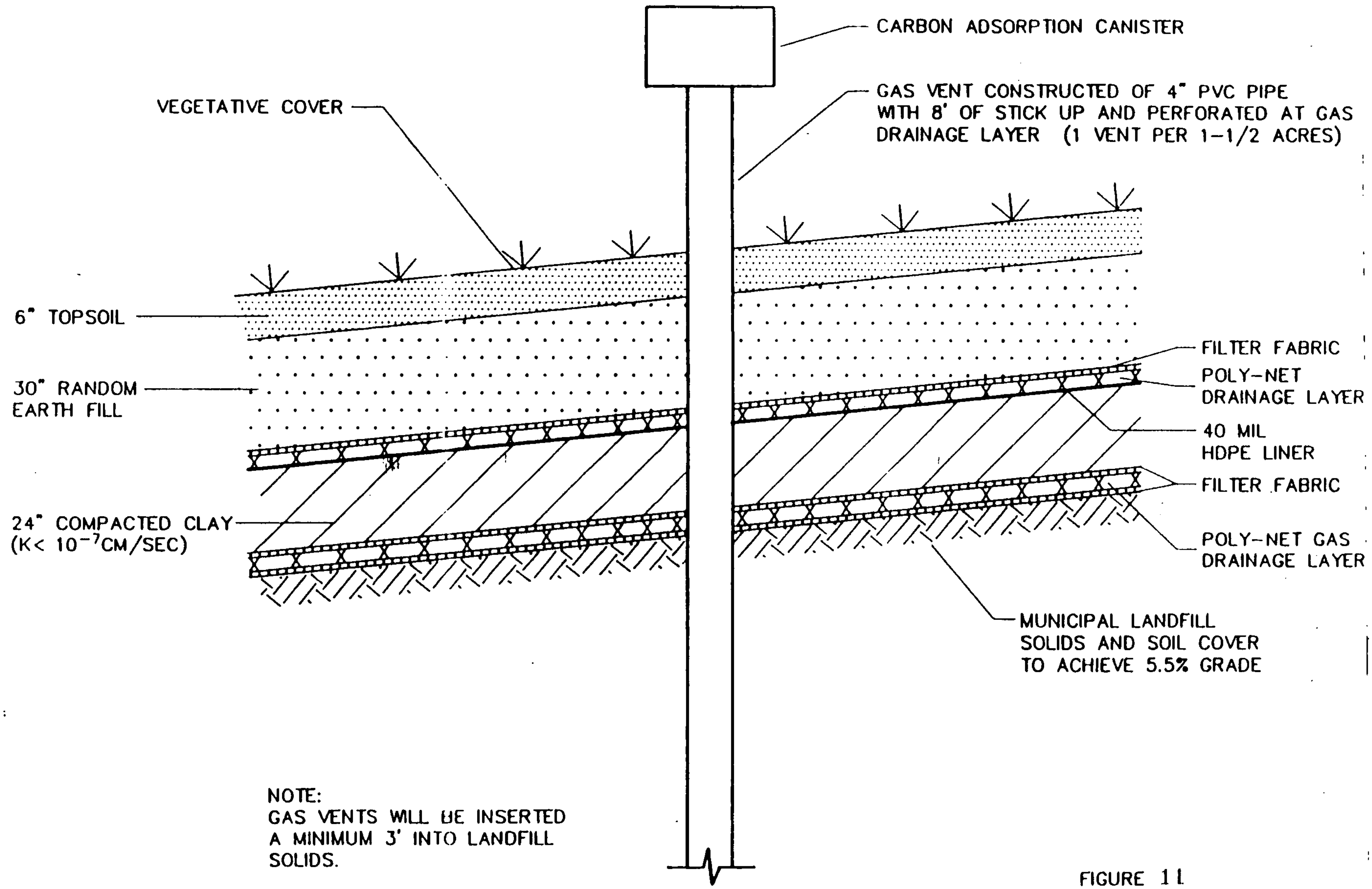


FIGURE 11
ALTERNATIVE 3
MULTI-LAYER CAP DETAIL
FULTZ LANDFILL SITE,
FEASIBILITY STUDY REPORT

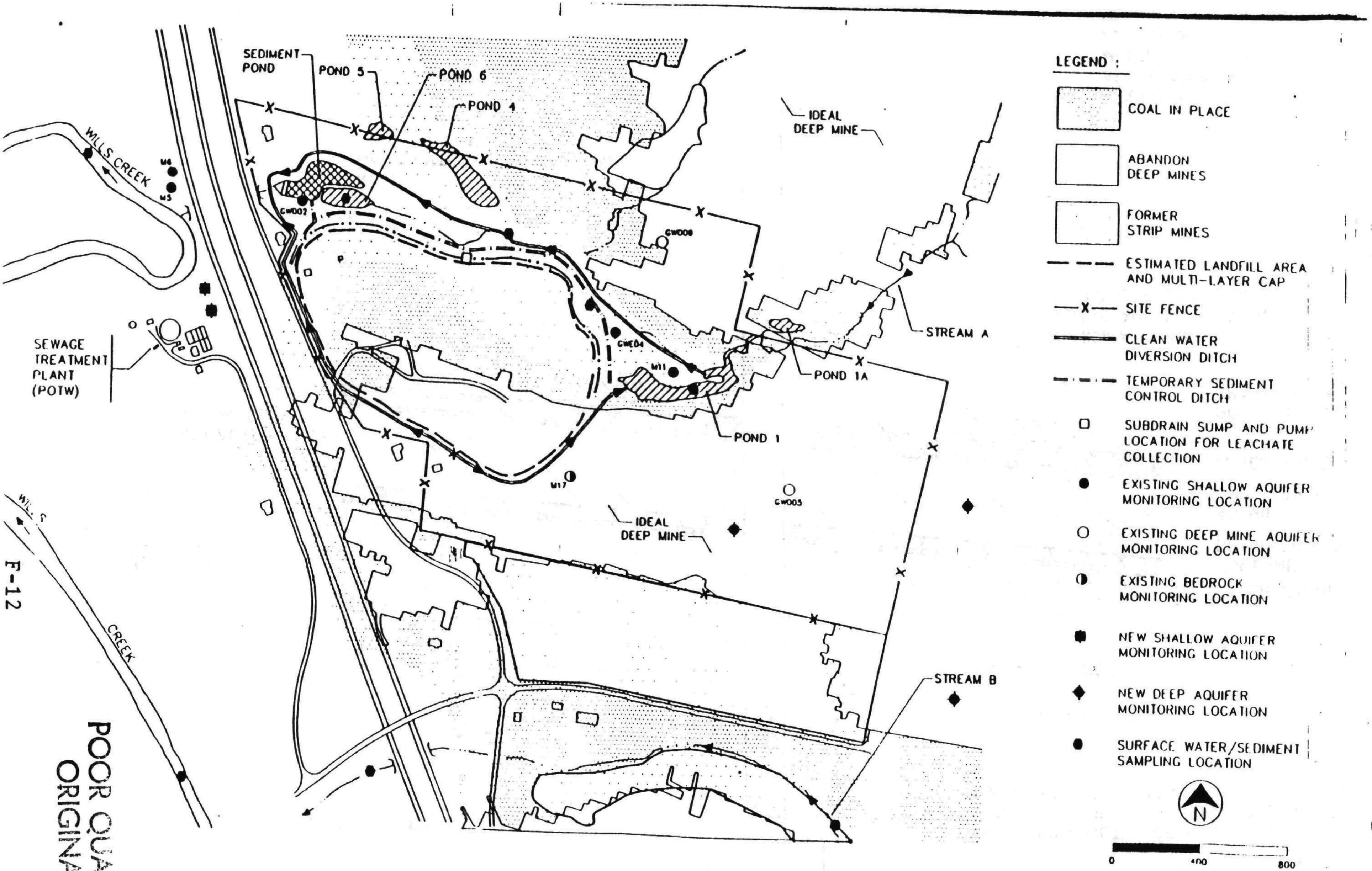


FIGURE 12
ALTERNATIVE 3
MULTI-LAYER CAP
FULTZ LANDFILL SITE,
FEASIBILITY STUDY REPORT

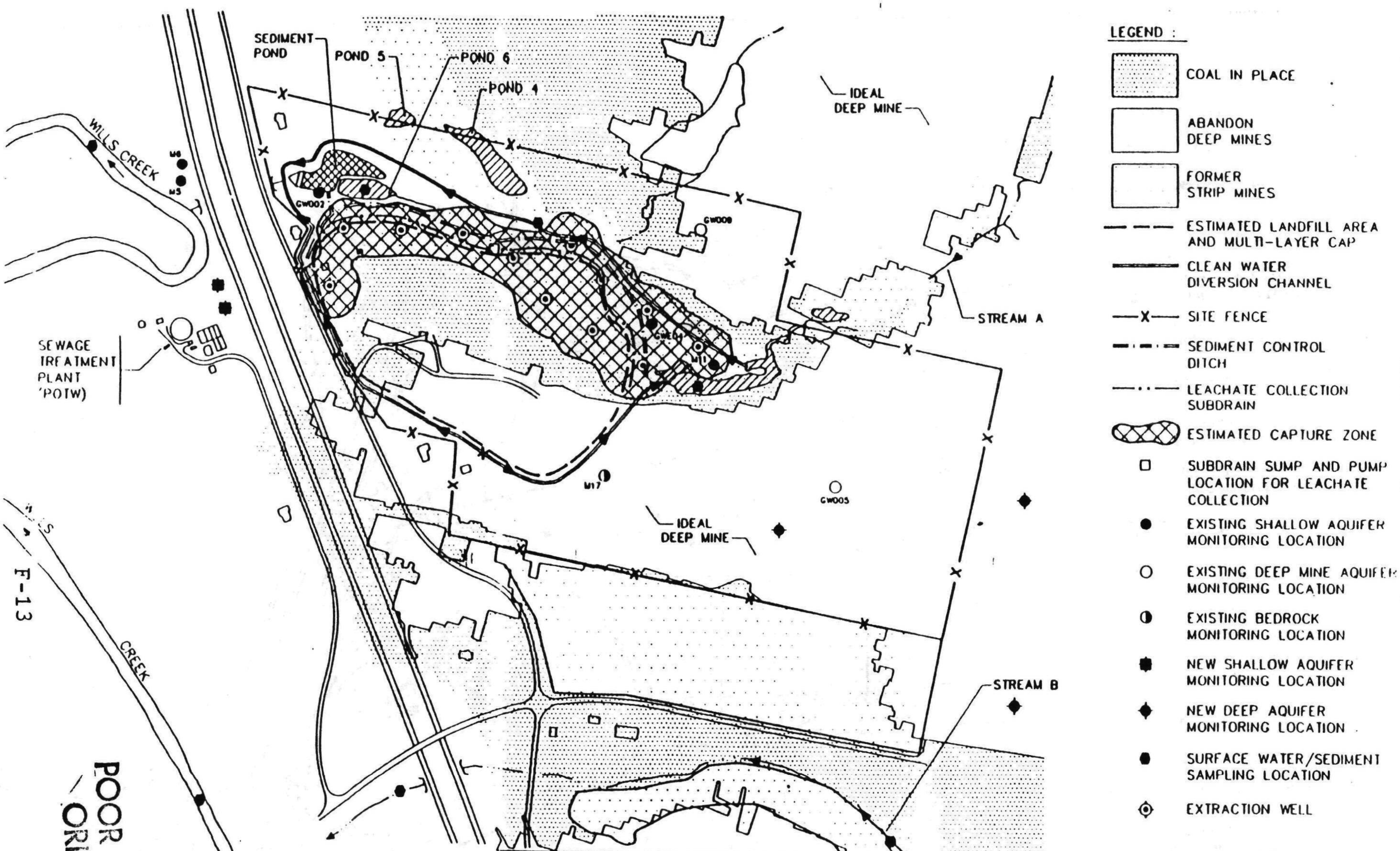


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FIGURE 13
ALTERNATIVE 4
MULTI-LAYER CAP WITH GROUNDWATER EXTRACTION AND TREATMENT
FULTZ LANDFILL SITE, FEASIBILITY STUDY REPORT

POOR QUALITY ORIGINAL

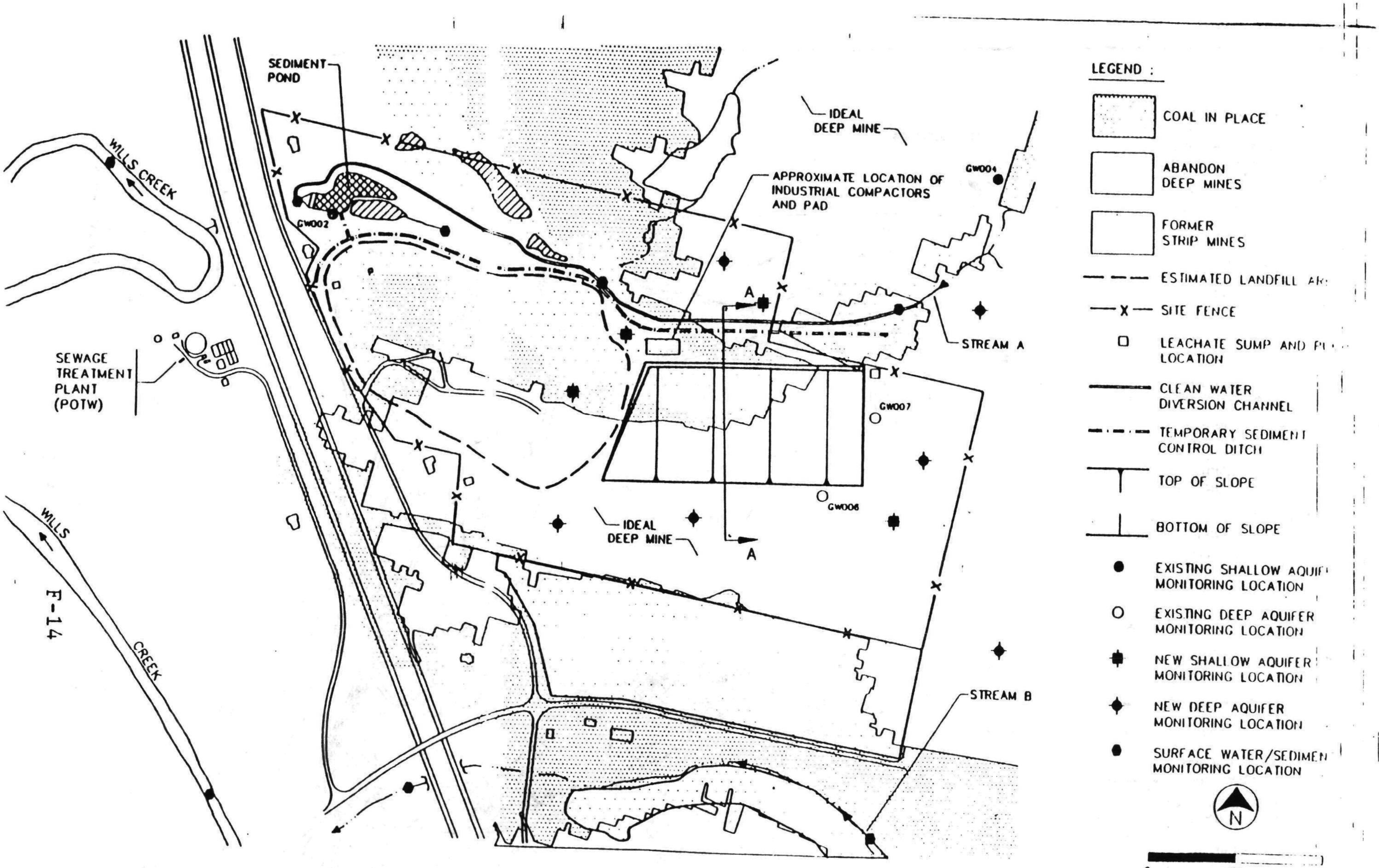

FIGURE 14
ALTERNATIVE 5
ONSITE LANDFILL
FULTZ LANDFILL SITE,
FEASIBILITY STUDY REPORT

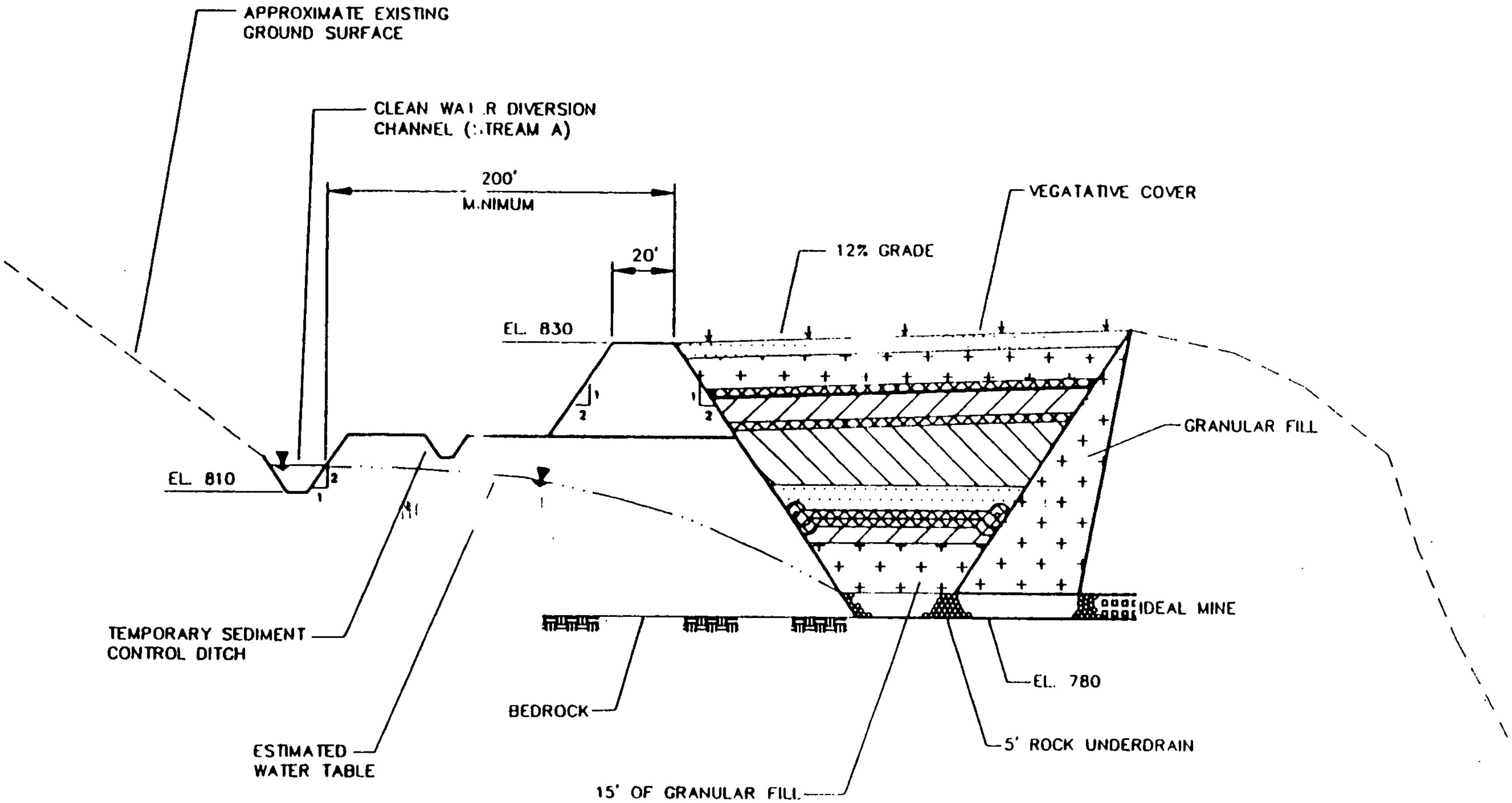

FIGURE 15
ALTERNATIVE 5
ON-SITE LANDFILL SECTION A-A
FULTZ LANDFILL SITE,
FEASIBILITY STUDY REPORT

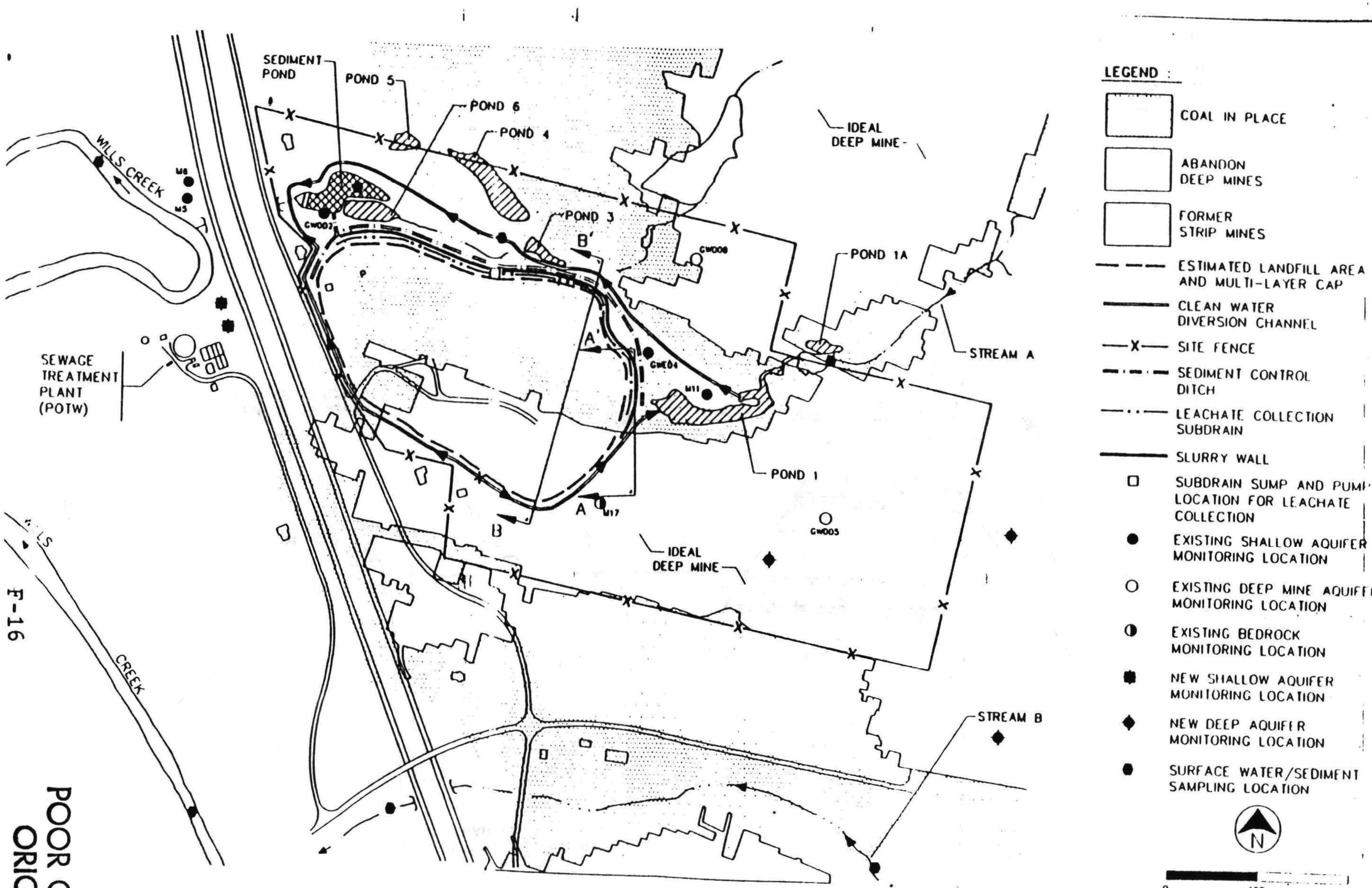

FIGURE 16
ALTERNATIVE 6
MULTI-LAYER CAP WITH
SUBSURFACE BARRIER
FULTZ LANDFILL SITE,
FEASIBILITY STUDY REPORT

TABLE 1
SUMMARY OF CHEMICALS DETECTED (a)
Fultz Landfill Site, Byesville, Ohio
Feasibility Study Report

CHEMICAL	Groundwater: Shallow Aquifer	Groundwater: Deep Aquifer	Groundwater: Residen-cial. Wells (b)	Groundwater: Byesville Plant No.2 Untreated	Groundwater: Byesville Plant No.2 Treated	Surface Water/Sediment: Leachate Seeps Water	Surface Water/Sediment: Leachate Seeps Sediment	Surface Water/Sediment: Ponds and Stream A Water	Surface Water/Sediment: Ponds and Stream A Sediment	Surface Water/Sediment: Wills Creek Water	Surface Water/Sediment: Wills Creek Sediment	Soil	Air
ORGANICS:													
Acetone	X	(X)		(X)		X	X		X			X	X
Benzene	X					X			(X)				X
Benzoic acid	X	X											
Benzyl alcohol						X							
Bis(2-ethylhexyl)phthalate	X	X				X	X		X				
Bromodichloromethane			(X)						X				
Bromoform									(X)				
2-Butanone	X	(X)											
Butylbenzylphthalate	X						X						
Carbon disulfide	X								(X)				X
Carbon tetrachloride				(X)									
Carcinogenic PAHs	X						X						
Chlorobenzene	X					X	X		X				
Chloroethane	X					X							
Chloroform									X				
Dibromochloromethane			(X)						(X)				
1,4-Dichlorobenzene							X						
3,3'-Dichlorobenzidene							X						
1,1-Dichloroethane									(X)				
1,1-Dichloroethene	X								(X)				
1,2-Dichloroethene (total)	X	X							(X)				
1,2-Dichloropropane									(X)				
cis-1,3-Dichloropropene									(X)				
trans-1,3-Dichloropropene									(X)				
Diethylphthalate	X					X							

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TABLE 1 Continued)

CHEMICAL	Groundwater					Surface Water/Sediment							
	Shallow Aquifer	Deep Aquifer	Residen-cial. Wells (b)	Byesville Plant No.2		Leachate Seeps		Ponds and Stream A		Wills Creek			
				Untreated	Treated	Water	Sediment	Water	Sediment	Water	Sediment	Soil	Air
2,4-Dimethylphenol	X												
Di-n-butylphthalate		X							X			X	
Di-n-octylphthalate	X						X						
Ethylbenzene	X	X				X	X		(X)				
4-Methyl-2-pentanone	X												
2-Methylphenol						X							
4-Methylphenol						X							
Methylene chloride	X						(X)					(X)	
N-nitrosodiphenylamine	X					X	X						
Noncarcinogenic PAHs	X	(X)				X	X		X				
Pentachlorophenol	X								X				
Phenol						X							
Styrene									(X)				
Tetrachloroethene									(X)			X	
Toluene	X	X				X	X	(X)	X			X	X
1,1,1-Trichloroethane									X				
1,1,2-Trichloroethane									(X)				
Trichloroethene								(X)	(X)				
Vinyl acetate									(X)				
Vinyl chloride	X	X											
Xylenes (total)	X	X				X	X		(X)				
INORGANICS:													
Aluminum	X	(X)	(X)					X					
Antimony	X	X							X				
Arsenic	X		(X)					X	X		X		
Barium	X	X	(X)			X		X	X				
Beryllium	X	X											
Cadmium	X	X							X				

TABLE 1 (Continued)

CHEMICAL	Groundwater					Surface Water/Sediment							
	Shallow Aquifer	Deep Aquifer	Residen-cial. Wells (b)	Byesville Plant No.2		Leachate Seeps		Ponds and Stream A		Wills Creek			
				Untreated	Treated	Water	Sediment	Water	Sediment	Water	Sediment	Soil	Air
Calcium	X					X	X		X				
Chloride	X	X											
Chromium	X	X				X							
Cobalt	X	X						X			X		
Copper	X	X			(X)			X					
Iron	X	X	(X)				X				X		
Lead	X	X	(X)										
Magnesium	X	X				X							
Manganese	X	X	(X)			X		X	X		X		
Mercury	X								X				
Nickel	X	X						X			X		
Potassium	X					X							
Selenium	X						X		X			X	
Silver	X						X		X				
Sodium	X					X			X		(X)		
Sulfate													
Thallium	X						X		X				
Vanadium	X	X									X		
Zinc	X	X	(X)										
Cyanide							X		X				

Notes: (a) Chemicals determined to be site-related and/or chemicals of potential concern based on the RI results.
X A chemical of potential concern in the risk assessment, and probably site-related.
(X) A chemical of potential concern in the risk assessment, but probably not site-related. Site-related chemicals were determined based on a comparison of the onsite versus background concentrations for each media.
(b) Some residential wells may be located in downgradient directions relative to the landfill.

POOR QUALITY ORIGINAL

30340-42-F

TABLE 2

SHALLOW AQUIFER DATA SUMMARY
FULTZ LANDFILL SITE
FINAL RI REPORT
(Concentrations in ug/l)

Chemical	Shallow Aquifer Frequency of Detection (a)	Shallow Aquifer Range of Detected Concentrations	Background (b) Frequency of Detection (a)	Background (b) Range of Detected Concentrations
Organics:				
* Acetone	3/28	4-6	0/3	<8-<10
* Benzene	1/29	1	0/3	<5
* Benzoic acid	2/28	0.9-1	0/3	<50-<100
* bis(2-Ethylhexyl)phthalate	7/29	4-100	0/3	<10-<20
* 2-Butanone	2/23	6-8.5	0/3	<6-<10
* Butylbenzylphthalate	1/28	2	0/3	<10-<20
* Carbon disulfide	1/27	2	0/3	<5
* Carcinogenic PAHs	1/29	2		
Chrysene	1/29	2	0/3	<10-<20
* Chlorobenzene	1/29	3	0/3	<5
* Chloroethane	2/29	1-7	0/3	<10
* 1,1-Dichloroethene	1/29	4	0/3	<5
* 1,2-Dichloroethene (total)	3/29	1-5	0/3	<5
* Diethylphthalate	3/27	8-24	0/3	<10-<20
* 2,4-Dimethylphenol	1/29	35	0/3	<10-<20
* Di-n-octylphthalate	2/29	7-13.5	0/3	<10-<20
* Ethylbenzene	3/29	1-2	0/3	<5
* 4-Methyl-2-pentanone	1/29	17	0/3	<10
* Methylene chloride	1/27	1	0/3	<5
* N-nitrosodiphenylamine	2/29	1.5-2	0/3	<10-<20
* Noncarcinogenic PAHs	5/29	3.4-812		
Anthracene	1/27	5	0/3	<10-<20
Dibenzofuran	3/29	6-77	0/3	<10-<20
Fluoranthene	1/29	14	0/3	<10-<20
Fluorene	1/29	12	0/3	<10-<20
2-Methylnaphthalene	5/29	0.1-380	0/3	<10-<20
Naphthalene	3/29	21-250	0/3	<10-<20
Phenanthrene	3/29	0.2-69	0/3	<10-<20
Pyrene	2/29	0.1-10	0/3	<10-<20
* Pentachlorophenol	1/28	3	0/3	<50-<100
* Toluene	4/28	1.8-3	0/3	<5
* Vinyl chloride	2/29	2-5	0/3	<10
* Xylenes (total)	3/29	2-12	0/3	<5
Inorganics:				
* Aluminum	27/27	208-911,000	3/3	38,300-125,000
* Antimony	10/24	14.6-132	0/3	<26-<58
* Arsenic	22/26	3.7-427	2/3	3.2-44
* Barium	28/28	60-6,000	3/3	262-486
* Beryllium	20/28	1.2-68	3/3	3-7
* Cadmium	11/22	0.3-77.7	0/3	<4-<5
* Calcium	28/28	11,200-432,000	3/3	69,500-103,000
* Chloride	20/23	3,000- 387,000	2/3	3,000-5,730
* Chromium	25/28	6-1,580	3/3	63.7-225
* Cobalt	23/28	18-806	3/3	47.2-130
* Copper	24/28	7-1,340	3/3	80.4-261
* Iron	28/28	1,220-1,860,000	3/3	77,300-266,000
* Lead	26/28	1.9-1,530	3/3	26.3-142
* Magnesium	28/28	31,100-217,000	3/3	34,500-55,700
* Manganese	28/28	348-25,100	2/3	765-1,020
* Mercury	16/28	0.2-1	0/3	<0.1-<0.8
* Nickel	25/28	7.8-1,630	3/3	110-355
* Potassium	24/28	2,600-97,600	3/3	15,200-24,000
* Selenium	2/20	7.8-10	0/3	<5-<10
* Silver	1/28	28	0/3	<3-<5
* Sodium	28/28	3,630-721,000	3/3	78,000-89,600
Sulfate	22/22	6,000-450,000	3/3	77,000-246,000
* Thallium	6/27	2.1-9.9	1/3	1.5
* Vanadium	23/28	25.8-1,610	3/3	56.9-218
* Zinc	28/28	44-4,890	3/3	278-957

(a) The number of samples in which the contaminant was detected divided by the total number of samples. The total number of samples will vary if the analysis of a sample for a specific contaminant was rejected during QA/QC of the data.
(b) The background well for the shallow aquifer is Well GW004.
* Chemical of potential concern.
(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit of < "___".

TABLE 3

DOWNGRADIENT COAL MINE AQUIFER DATA SUMMARY
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/l)

Chemical	Coal Mine Aquifer: Frequency of Detection (a)	Coal Mine Aquifer: Range of Detected Concentrations	Background (b): Frequency of Detection (a)	Background (b): Range of Detected Concentrations
Organics:				
* Acetone	4/11	4 - 22.5	3/5	7 - 17
* Benzoic acid	1/11	37	0/5	<50 - <100
* bis(2-Ethylhexyl)phthalate	3/11	3 - 150	1/5	15
* 1,2-Dichloroethene (total)	2/12	1.5 - 3	0/5	<5
* 2-Butanone	3/9	7 - 8	2/4	7
* Di-n-butylphthalate	1/11	4.5	0/4	<3 - <27
* Ethylbenzene	1/12	2	0/5	<5
* 2-Methylnaphthalene	1/12	1	1/5	9
Naphthalene	0/12	N/A	1/5	6
* Toluene	2/12	1 - 3	0/5	<5
* Vinyl chloride	2/12	1.5 - 7	0/5	<10
* Xylenes (total)	1/12	2	0/5	<5
Inorganics:				
* Aluminum	11/11	1,030 - 242,000	2/4	1,050 - 14,100
* Antimony	2/9	33.3 - 58	0/4	<25 - <58
Arsenic	8/11	10 - 49.3	3/5	17.3 - 392
* Barium	12/12	57 - 1,810	5/5	41 - 322
* Beryllium	4/12	0.5 - 18	2/5	2.4 - 3
* Cadmium	1/9	11.4	1/4	4.5
Calcium	12/12	36,850 - 202,000	5/5	38,300 - 364,000
* Chloride	12/12	10,000 - 150,000	5/5	4,000 - 53,700
* Chromium	10/12	5.6 - 345	3/5	16.6 - 56
* Cobalt	6/12	5.9 - 222	1/5	24.7
* Copper	10/12	11.3 - 526	5/5	7.4 - 34
* Iron	12/12	5,300 - 422,000	5/5	6,140 - 74,000
* Lead	12/12	4.4 - 273	4/5	10 - 33.7
* Magnesium	12/12	11,900 - 126,000	5/5	10,000 - 22,200
* Manganese	12/12	236 - 19,600	5/5	236 - 471
Mercury	2/12	0.2 - 0.6	1/5	1.2
* Nickel	8/12	7.7 - 461	4/5	11 - 55.6
Potassium	12/12	3,270 - 32,100	5/5	3,370 - 50,600
Selenium	2/7	1.2 - 2.3	1/2	3.1
Sodium	12/12	21,200 - 71,400	5/5	39,500 - 238,000
Sulfate	12/12	60,500 - 257,000	5/5	57,000 - 530,000
Thallium	2/12	2.2 - 2.5	1/4	3.7
* Vanadium	6/12	7.3 - 459	2/5	16.4 - 30
* Zinc	12/12	35 - 1,300	5/5	61 - 158

(a) The number of samples in which the contaminant was detected divided by the total number of samples. The total number of samples will vary if the analysis of a sample for a specific contaminant was rejected during QA/QC of the data.
(b) The background samples for the coal mine aquifer are samples from GW008 (1985 and 1986), and GW009 (1985, 1986, and 1989).
* Chemical of potential concern.
(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit of < "___".

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TABLE 4

CHEMICAL CONCENTRATIONS IN RESIDENTIAL WELLS
FULTZ LANDFILL SITE
FINAL RI REPORT

Compound	Concentrations (ug/liter) (a)					
	RW001	RW002	RW003	RW005	RW007	RW004 (b)
Organics:						
Bromodichloromethane	NS	1.2 *	<0.5	<0.5	<0.5	<0.5
Chlorodibromomethane	NS	0.6 *	<0.5	<0.5	<0.5	<0.5
Trichloroethylene	NS	<0.5	<0.5	<0.5	<0.5	3.3
Inorganics (total):						
Aluminum	<80	131 *	1,400 *	<80	<80	<80
Arsenic	5 *	<2	24 *	<2	<2	<2
Barium	36.5	50.3	395 *	175 *	86.1	82
Iron	3,270 *	635 *	9,680 *	886 *	80	293
Lead	<2	<2	6 *	<2	<2	2
Manganese	584 *	556 *	280 *	15	20.3 *	8.7
Zinc	<40	50.5	221 *	<40	<40	111

(a) Maximum values detected for each chemical. All wells were sampled once in 1985. Wells RW001, RW003, and RW005 were sampled again for organic chemicals only in 1986. Trichloroethylene in RW001 was the only organic chemical detected in the 1986 samples.

(b) Background well.

(<___) Chemical was not detected at a concentration above the CLP Contract Required Quanti Limit of < "___".

NS Not sampled.

* Chemical of potential concern.

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TABLE 5

CHEMICAL CONCENTRATIONS DETECTED IN THE
BYESVILLE COMMUNITY WATER SUPPLY
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/l)

Chemical	Pretreatment (a)	Post Treatment (b)	Background (c) Frequency of Detection (d)	Background (c) Range of Detected Concentrations
Organics:				
Acetone	10.5 *	<10	2/5	7-17
# Carbon tetrachloride	8.3 *	<5	0/5	<5
Inorganics:				
Aluminum	<80-72.6	62.2	2/4	1,050-14,100
Antimony	<20	<20	0/4	<25-<58
Arsenic	<2-<5	<5	3/5	17.3-392
Barium	13.9-75	78.9	5/5	41-322
Beryllium	<1	<1	2/5	2.4-3.0
Cadmium	<1	<1	1/4	4.5
Calcium	35,100	35,600	5/5	38,300-364,000
Chloride	78	85	5/5	4,000-53,700
Chromium	17.7	16.1	3/5	16.6-56
Cobalt	<8	<8	1/5	24.7
Copper	25.5	133 *	5/5	7.4-34
Iron	2,860-3,090	83.1	5/5	6,140-74,000
Lead	<2-<3	<3	4/5	10-33.7
Magnesium	6,870	12,800	5/5	10,000-22,200
Manganese	258-297	414	5/5	236-471
Mercury	<0.2	<0.2	1/5	1.2
Nickel	<14	<14	4/5	11-55.6
Potassium	3,770	4,000	5/5	3,370-50,600
Selenium	<5	<5	1/2	3.1
Sodium	223,000	226,000	5/5	39,500-238,000
Sulfate	157.5	154	5/5	57,000-530,000
Thallium	<20	<20	1/4	3.7
Vanadium	<6	<6	2/5	16.4-30
Zinc	<40-25	32.5	5/5	61-158

(a) Values presented are the arithmetic means of the sample (GW-019) and a duplicate (GW-020) and Phase I sample RW006.
(b) Sample GW-022 (Minarchek tap).
(c) Coal mine aquifer wells GW008 and GW009.
(d) The number of samples in which the contaminant was detected divided by the total number of samples.

* = Chemicals of potential concern.
(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit of < "___".

Carbon Tetrachloride was only detected once during sampling.

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TABLE 6

PHASE II LEACHATE DATA SUMMARY
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/l)

Chemical	Leachate Water: Frequency of Detection	Leachate Water: Range of Detected Concentration	Background (a): Frequency of Detection	Background (a): Range of Detected Concentration
Organics:				
* Acetone	6/7	9-52.5	0/3	<10
* Benzene	5/7	2-6	0/3	<5
* Benzyl alcohol	1/7	15	0/3	<10
* bis(2-Ethylhexyl)phthalate	1/7	6	0/3	<10
* Chlorobenzene	3/7	3-130	0/3	<5
* Chloroethane	3/7	11.5-13	0/3	<10
* Diethylphthalate	1/7	3	0/3	<10
* Ethylbenzene	5/7	5.5-150	0/3	<5
* 2-Methylphenol	1/7	45	0/3	<10
* 4-Methylphenol	1/7	25	0/3	<10
* N-nitrosodiphenylamine	1/7	6.5	0/3	<10
* Noncarcinogenic PAHs	2/7	2-5	0/3	<10
Naphthalene	2/7	2-5	0/3	<10
* Phenol	1/7	21.5	0/3	<10
* Toluene	4/7	6-87	0/3	<5
* Xylenes (total)	5/7	18-47	0/3	<5
Inorganics:				
Aluminum	7/7	159-782.5	3/3	38,300-125,000
Arsenic	4/7	2.2-6.5	2/3	3.2-44
* Barium	7/7	283-2,155	3/3	262-486
* Calcium	7/7	104,500-282,000	3/3	69,500-103,000
* Chromium	7/7	173-900.5	3/3	63.7-95
Cobalt	7/7	5.3-13.5	3/3	47.2-130
Copper	7/7	8-32.4	3/3	80.4-261
Iron	7/7	2,920-79,800	3/3	77,300-266,000
Lead	7/7	2.3-15.3	3/3	26.3-142
* Magnesium	7/7	45,450-282,000	3/3	34,500-55,700
* Manganese	7/7	1,150-9,070	2/3	765-1,020
Nickel	7/7	156-674	3/3	110-355
* Potassium	7/7	8,330-90,100	3/3	15,200-24,000
* Sodium	7/7	48,000-386,000	3/3	78,000-89,600
Vanadium	6/7	6.5-52.6	3/3	56.9-218
Zinc	7/7	17.3-364	3/3	278-957

(a) The background for the leachate water samples is the shallow aquifer background well (GW004).

* Chemicals of potential concern.

(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit of <"___".

TABLE 7

LEACHATE SEDIMENT DATA SUMMARY
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/kg)

Chemical	Leachate Sediment: Frequency of Detection	Leachate Sediment: Range of Detected Concentration	Background (a): Frequency of Detection	Background (a): Range of Detected Concentration
Organics:				
* Acetone	2/9	10-19	0/3	<10
* Bis(2-ethylhexyl)phthalate	7/9	99-980	0/3	<330
* Butylbenzylphthalate	3/9	62-310	0/3	<330
* Carcinogenic PAHs	2/9	75-120	0/3	<330
Benzo(a)anthracene	2/9	75-120	0/3	<330
* Chlorobenzene	2/9	15-57	0/3	<5
* 1,4-Dichlorobenzene	1/9	180	0/3	<5
* 3,3'Dichlorobenzidene	1/9	1,200	0/3	<20
* Di-n-octylphthalate	1/9	190	0/3	<330
* Ethylbenzene	2/9	7-64	0/3	<5
* Noncarcinogenic PAHs	3/9	315-1,107	1/3	<850-110
Dibenzofuran	1/9	97	0/3	<330
Fluoranthene	1/9	300	0/3	<330
Naphthalene	3/9	120-280	1/3	110
Phenanthrene	3/9	170-450	0/3	<330
* Methylene chloride	3/9	4-10	2/3	14-32
* N-nitrosodiphenylamine	1/9	100	0/3	<10
* Toluene	3/9	5-24	0/3	<5
* Xylenes (total)	2/9	6-7.5	0/3	<5
Inorganics:				
Aluminum	8/8	8,150-11,900	3/3	10,000-11,800
Arsenic	8/8	4.1-22	3/3	6.1-7.6
Barium	8/8	137-831	3/3	73.5-209
Beryllium	8/8	0.6-1.1	2/3	0.7-1.3
Cadmium	2/8	1.1-3.1	3/3	0.8-1.3
* Calcium	8/8	3,320-90,700	3/3	380-2,330
Chromium				
Cobalt	8/8	9.9-18.4	3/3	14.1-20.9
Copper				
* Iron	8/8	37,000-61,600	3/3	15,800-33,700
Lead	8/8	17.1-49	3/3	13.6-48.6
Magnesium	8/8	2,720-6,690	3/3	1,320-3,440
Manganese	8/8	448-5,490	3/3	455-831
Mercury	1/8	0.1	1/3	0.2
Nickel	8/8	17-38.5	3/3	13.1-48.3
Potassium	8/8	921-2,270	3/3	648-1,720
* Selenium	2/8	0.6-0.7	0/3	<0.74-<0.76
* Silver	1/8	1.2	1/3	0.5
Sodium	1/8	505	3/3	76.7-564
* Thallium	1/8	0.6	0/3	<10
Vanadium	8/8	30.5-88.1	3/3	21.4-41
Zinc				
* Cyanide	1/8	0.7	0/3	<10

(a) The background samples for the leachate sediment are the off-site soil samples (SO-011, SO-012, and SO-013).

* = Chemicals of potential concern

(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitatio Limit of < "___".

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TABLE 8

SURFACE WATER DATA SUMMARY
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/l)

CHEMICAL	SAMPLE #: LOCATION:	SW-001 POND 1 (a)	SW-006 POND 1A	SW-002 POND 2	SW-003 POND 3	SW-004 POND 4	SW-005 POND 5	SW-008 DOWNSTR A	SW-007 UPSTREAM A (Background)
Organics:									
Styrene		<5	<5	<5	<5	<5	<5	<5	2
Toluene		<5	<5	<5	<5	<5	<5	3 *	<5
Trichloroethene		1.75 *	<5	<5	<5	<5	<5	<5	<5
Inorganics:									
Aluminum		195 *	201 *	<200	<200	<200	<200	<200	<200
Antimony		<27	<27	<27	<27	<27	<27	<24.7	<24.7
Arsenic		2.9 *	3.4 *	2.7 *	2.2 *	<2	<2	<2	<2
Barium		39.2	53.8	69.6	49.2	46.8	19	84.8 *	39.6
Beryllium		<2	<2	<2	<2	<2	<2	<0.5	<0.5
Cadmium		<4	<4	<4	<4	<4	<4	<3.6	<3.6
Calcium		34400	30800	43000	58100	61200	23500	93200	77200
Chromium		<4	<4	<4	<4	<4	<4	<5.5	<5.5
Cobalt		5.1 *	<5	<5	<5	<5	<5	<4.1	<4.1
Copper		7.1 *	<4	<4	<4	7.3 *	5.5 *	<6	<6
Iron		259	975	1360	88.5	157	352	1240	913
Lead		<1	<1	<1	<1	<1	<1	<1	<1
Magnesium		14400	12500	19600	23700	24600	9020	39000	32200
Manganese		823.5 *	339 *	626 *	485 *	146 *	251 *	1530 *	28.3
Mercury		<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel		13.9 *	<9	<9	<9	<9	<9	<5.8	<5.8
Potassium		1580	3460	3010	3100	2600	2530	2110	2220
Selenium		<3	<3	<3	<3	<3	<3	<1	<1
Silver		<9	<9	<9	<9	<9	<9	<3.9	<3.9
Sodium		14100	2510	17400	40500	45600	1360	40700	28200
Thallium		<3	<3	<3	<3	<3	<3	<2	<2
Vanadium		<5	<5	<5	<5	<5	<5	<5	<5.5
Zinc		<5	<5	<5	<5	<5	<5	<5	<5
Cyanide		<10.6	<10	<11.1	<10	<10	<10	<10	<10

(a) Values presented are the arithmetic means of the sample and a duplicate sample.
* Chemical of potential concern.
(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit of < "___".

TABLE 9

SEDIMENT DATA SUMMARY
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/kg)

CHEMICAL	SAMPLE #: LOCATION:	SD-013 POND 1 (a)	SD-017 POND 1A (b)	SD-014 POND 2	SD-015 POND 3	SD-016 POND 4	SD-018 POND 5	SD-020 DOWNSTR A	SD-019 UPSTREAM A (Background)
Organics:									
Acetone		<43	<27	<20	<30	<61	<38	350 + *	<12
Benzene		<9	17 *	<10	<15	<14	<19	<22	<6
bis(2-Ethylhexyl)phthalate		510 + *	<1800	<1300	160 + *	<1900	<2500	<2900	<810
Bromodichloromethane		2 + *	8 *	<10	<15	<14	<19	<22	<6
Bromoform		<9	4 *	<10	<15	<14	<19	<22	<6
Carbon disulfide		<10	27 *	<10	<15	<14	<19	<22	<6
Chlorobenzene		43 + *	77 *	48 + *	64 + *	68 + *	86 + *	<22	<6
Chloroform		2	21 *	2	3	3	4	7 + *	2
cis-1,3-Dichloropropene		<9	7 *	<10	<15	<14	<19	<22	<6
Dibromochloromethane		<9	6 *	<10	<15	<14	<19	<22	<6
1,1-Dichloroethane		<10	18 *	<10	<15	<14	<19	<22	<6
1,1-Dichloroethene		<10	18 *	<10	<15	<14	<19	<22	<6
1,2-Dichloroethene (total)		<10	17 *	<10	<15	<14	<19	<22	<6
1,2-Dichloropropane		<9	16 *	<10	<15	<14	<19	<22	<6
trans-1,3-Dichloropropene		<9	7 *	<10	<15	<14	<19	<22	<6
Di-n-butylphthalate		85 + *	<1800	<1300	<2000	220 + *	<2500	<2900	<810
Ethylbenzene		<9	17 *	<10	<15	<14	<19	<22	<6
Noncarcinogenic PAHs		<1200	<1800	<1300	<1900	<1900	<2500	970 + *	<810
Acenaphthene		<1200	<1800	<1300	<2000	<1900	<2500	110	<810
Fluoranthene		<1200	<1800	<1300	<2000	<1900	<2500	340	<810
Phenanthrene		<1200	<1800	<1300	<2000	<1900	<2500	180	<810
Pyrene		<1200	<1800	<1300	<2000	<1900	<2500	340	<810
Pentachlorophenol		390 + *	<8600	<6500	<9600	<9000	<12000	<14000	<4800
Styrene		<9	12 *	<10	<15	<14	<19	<22	<6
Tetrachloroethene		<9	20 *	<10	<15	<14	<19	<22	<6
Toluene		150 + *	19 *	4 + *	<15	<14	<19	7 + *	<6
1,1,1-Trichloroethane		6 + *	25 *	5 + *	8 + *	7 + *	10 + *	<22	<6
1,1,2-Trichloroethane		<9	12 *	<10	<15	<14	<19	<22	<6
Trichloroethene		<9	16 *	<10	<15	<14	<19	<22	<6
Vinyl acetate		<9	27 *	<20	<30	<28	<38	<43	<12
Xylenes (total)		<9	14 *	<10	<15	<14	<19	<22	<6

(a) Values presented are the arithmetic means of the sample and a duplicate sample.
(b) Not site-related because Pond 1A is upgradient of the site.
\+ Indicates a site-related concentration.
* Chemical of potential concern (Section 6.2).
(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit of < "___".

TABLE 8 (Continued)

SEDIMENT DATA SUMMARY
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/kg)

CHEMICAL	SAMPLE #: LOCATION:	SD-013 POND 1 (a)	SD-017 POND 1A (b)	SD-014 POND 2	SD-015 POND 3	SD-016 POND 4	SD-018 POND 5	SD-020 DOWNSTR A	SD-019 UPSTREAM A (Background)
Inorganics:									
Aluminum		13950	13800	19300	15200	13500	16100	13500	13300
Antimony		<11	<14.9	9.6 + *	<14	<15.9	<19.2	<26.7	<6.5
Arsenic		10.1	5.4	10.4	6.1	6.6	8.7	54.1 + *	26.2
Barium		134	108	116	186	92.4	107	460 + *	222
Beryllium		1.1	1.4	1	1.5	1.5	<1.4	1.3	1.6
Cadmium		<1.65	<2.2	<1.4	<2.1	<2.4	<2.8	6.7 + *	<0.95
Calcium		2450	5960	1350	6030	5570	5190	11800 + *	3360
Chromium		21.6	23.1	24.4	26.2	23.2	28	21.1	25.9
Cobalt		13.1	15.6	13.3	17.4	17.7	17.9	16.5	38.7
Copper		23.6	24.9	22.7	33.5	30.6	31.2	61.3	91.8
Iron		26050	26000	30900	32700	27100	31600	81700	70100
Lead		14.25	14.6	16.4	15.5	19	20.6	28.6	30.4
Magnesium		3020	5270	32.8	4250	3580	4910	4700	4340
Manganese		527.5	479	267	736	1310	1550	14300 + *	2590
Mercury		<.2	<0.25	<0.18	<0.24	<0.25	0.3 + *	<0.54	<0.13
Nickel		24.3	31.1	26.1	32	34.8	36.5	25.6	41.8
Potassium		1660	1730	1550	1680	2000	2160	2300	1400
Selenium		<1.2	<1.6	<1.1	<1.5	<1.8	2.2 + *	<1.1	<0.26
Silver		<3.7	<5	<3.2	<4.7	<5.3	6.4 + *	5.1 + *	<1
Sodium		123 + *	139 + *	170 + *	236 + *	395 + *	136 + *	<1840	<447
Thallium		<1.2	<1.6	<1.1	<1.5	<1.8	2.2 + *	<2.2	<0.53
Vanadium		30.3	31	38.3	36.1	34.8	67.5	41.6	40.8
Zinc		71.3	81.7	79.2	95.8	88.3	99.1	171	112
Cyanide		<2	<2.8	<1.9	<2.7	<3.2	3.7 + *	<2.7	<0.66

(a) Values presented are the arithmetic means of the sample and a duplicate sample.
(b) Not site-related because Pond 1A is upgradient of the site.
+ Indicates a site-related concentration.
* Chemical of potential concern (Section 6.2).
(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit of < "___".

TABLE 10

WILLS CREEK SURFACE WATER DATA SUMMARY
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/l)

CHEMICAL	SAMPLE #: LOCATION:	SW-010 UPS TNT PLT	SW-011 DS TNT PLT	SW-012 DS WILLS CK	SW-009 IDEAL BRDG (Background)
Organics:					
Di-n-butyl phthalate		<10	<10	<10	0.6
Inorganics:					
Aluminum		1360	489	448	816
Antimony		<24.7	<24.7	<24.7	<24.7
Arsenic		<2	<2	<2	<2
Barium		<106	105	99.2	104
Beryllium		<0.5	<0.5	<0.5	<0.5
Cadmium		<3.6	<3.6	<3.6	<3.6
Calcium		159000	164000	156000	166500
Chromium		<5.5	<5.5	<5.5	<5.5
Cobalt		<4.1	<4.1	<4.1	<4.1
Copper		<6	<6	<6	<6
Iron		1960	955	833	1344
Lead		<1	<1	<1	<1
Magnesium		72900	74700	70400	77350
Manganese		395	402	359	383
Mercury		0.2	<0.2	<0.2	<0.2
Nickel		<5.8	<5.8	<5.8	<5.8
Potassium		3700	3760	3660	3680
Selenium		<1	<1	<1	<5.5
Silver		<3.9	<3.9	<3.9	<3.9
Sodium		99500	105000	100000	109500
Thallium		<2	<2	<2	<2
Vanadium		<5.5	<5.5	<5.5	<5.5
Zinc		<5	<5	<5	<5
Cyanide		<10	<10	<10	<10

(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit of < "___".

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TABLE 11

WILLS CREEK SEDIMENT DATA SUMMARY
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/kg)

CHEMICAL	SAMPLE #: / LOCATION:	SD-022 UPS TMT PLT	SD-023 DS TMT PLT	SD-024 DS WILLS	SD-021 (a) IDEAL BRDG (Background)
Organics:					
Acetone		<20	<16	<13	48.5
Chloroform		<10	3	<6	2.5
Di-n-butylphthalate		<1300	<1000	<840	180
Toluene		<10	<8	1	11.8
Carcinogenic PAHs		<1300	<1000	<840	2725
Benzo(a)anthracene		<1300	<1000	<840	735
Benzo(a)pyrene		<1300	<1000	<840	605
Benzo(b)fluoranthene		<1300	<1000	<840	545
Chrysene		<1300	<1000	<840	840
Noncarcinogenic PAHs		1012	303	396	6809.5
Acenaphthalene		<1300	<1000	<840	110
Acenaphthene		<1300	<1000	<840	70.5
Anthracene		<1300	<1000	<840	334
Dibenzofuran		<1300	<1000	<840	140
Fluoranthene		350	100	130	2000
Fluorene		<1300	<1000	<840	400
2-Methylnaphthalene		82	39	41	230
Naphthalene		<1300	<1000	<840	170
Phenanthrene		230	75	95	1655
Pyrene		350	89	130	1700
Inorganics:					
Aluminum		12200	9670	11500	8685
Antimony		<10.2	<7.9	<6.6	<10.2
Arsenic		16.2	19.1	77 + *	22.5
Barium		113	97.3	137	103.5
Beryllium		0.88	1.2	1.5	1.1
Cadmium		<1.5	<1.2	<0.96	<1.4
Calcium		7390	3660	2840	7560
Chromium		23	19.2	26.7	15.3
Cobalt		20	21.1	40.7 + *	16
Copper		29.5	23.2	24.4	31.8
Iron		29700	43300	68500 + *	28900
Lead		24.1	12.7	30.9	162.6
Magnesium		4330	3030	3540	2910
Manganese		1400	1380	2170 + *	1014
Mercury		<0.21	<0.16	<0.13	<.2
Nickel		35.9	37.4	73.2 + *	23.2
Potassium		2190	1340	978	1120
Selenium		<0.41	<0.32	<0.27	<.41
Silver		<1.6 *	<1.2 *	<1	<1.6
Sodium		705 *	545 *	<453	<702
Thallium		<0.83	<0.64	<0.53	<.83
Vanadium		25.2	25.5	55.8 + *	22.7
Zinc		96.4	81.9	128	94.1
Cyanide		<1	<0.8	<0.67	<1

(a) Values presented are the arithmetic means of the sample and a duplicate sample.

\+ Indicates a site-related concentration.

* Chemical of potential concern (Section 6.2).

(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit < "___".

TABLE 12

ON-SITE SURFACE SOIL DATA
FULTZ LANDFILL SITE
FINAL RI REPORT

(Concentrations in ug/kg)

Chemical	Surface Soil: Frequency of Detection	Surface Soil: Range of Detected Concentration	Background (a): Frequency of Detection	Background (a): Range of Detected Concentration
Organics:				
* Acetone	4/12	13-480	0/3	<10
* Di-n-butyl phthalate	6/11	310-720	0/3	<330
* Methylene chloride	8/12	8-56	2/3	14-32
Noncarcinogenic PAHs	0/12	<330	1/3	260
Naphthalene	0/12	<330	1/3	110
2-Methylnaphthalene	0/12	<330	1/3	150
* Tetrachloroethene	1/12	8	0/3	<5
* Toluene	4/12	4-120	0/3	<5
Inorganics:				
Aluminum	10/10	8190-15075.6	3/3	10000-11800
Arsenic	10/10	4.9-27.2	3/3	6.1-7.6
Barium	10/10	45.3-264.6	3/3	73.5-209
Beryllium	10/10	0.7-1.4	2/3	0.7-1.3
* Cadmium	9/10	1.6-3.8	3/3	0.8-3.05
Calcium	10/10	489-8230	3/3	380-2330
Chromium	10/10	21.1-37.1	3/3	14.6-34.1
Cobalt	10/10	12.5-23.8	3/3	14.1-20.9
Copper	10/10	22.9-219	3/3	11.6-24.7
Iron	10/10	27200-43800	3/3	15800-33700
Lead	10/10	20-34.4	3/3	13.6-48.6
Magnesium	10/10	2450-5416.2	3/3	1320-3440
Manganese	10/10	233.5-872	3/3	455-831
Mercury	2/10	0.2	1/3	0.2
Nickel	10/10	23.2-58.2	3/3	13.1-48.3
Potassium	10/10	704-3165	3/3	648-1720
* Selenium	1/10	2	0/3	<0.75
Silver	7/10	0.5-1.2	1/3	0.5
Sodium	10/10	55.5-452	3/3	76.7-564
Vanadium	10/10	22.5-46.2	3/3	21.4-41
Zinc	10/10	74.2-1[illegible]3	3/3	44.8-122

(a) The background samples for the on-site soil are SO-011, SO-012, and SO-013.
(b) Site-related chemicals for this media are based on the evaluation criteria discussed in Section 4.1.3.
* Chemicals of potential concern.
(<___) Chemical was not detected at a concentration above the CLP Contract Required Quantitation Limit of < "___".

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TABLE 13

CONCENTRATIONS OF CHEMICALS DETECTED IN AIR
FULTZ LANDFILL SITE
FINAL RI REPORT

CHEMICAL	FREQUENCY	MAXIMUM CONCENTRATION (ppb)	MAXIMUM CONCENTRATION (ug/m3)
* Acetone	4/7	45.1	107
* Benzene	1/7	7.15	21.5
* Carbon disulfide	1/7	0.953	2.86
* Toluene	2/7	0.701	2.63

* = Chemical of potential concern.

TABLE 14

SLOPE FACTOR HEALTH EFFECTS CRITERIA FOR EXPOSURE TO CHEMICALS OF POTENTIAL CONCERN
FULTZ LANDFILL SITE
FINAL RI REPORT

Chemical (a)	Slope Factor (SF) (mg/kg/day)-1	Weight-of-Evidence Classification (b)	Type of Cancer (c)	SF Basis	SF Source (d)
ORAL					
Organics:					
1,1,2-Trichloroethane	5.7E-02	C	Liver	Gavage	IRIS
1,1-Dichloroethane	9.1E-02	B2	Hemangiosarcoma	Gavage	HEA
1,1-Dichloroethene	6.0E-01	C	Adrenal	Gavage	IRIS
1,2-Dichloropropane	6.8E-02	B2	Liver	Gavage	HEA
1,4-Dichlorobenzene	2.4E-02	B2	Liver	Gavage	HA
3,3-Dichlorobenzidene	4.5E-01	B2	Mammary	Diet	HEA
Benzene	2.9E-02	A	Blood	Oral	IRIS
bis(2-Ethylhexyl)phthalate	1.4E-02	B2	Liver	Diet	IRIS
Bromodichloromethane	1.3E-01	B2	Liver	Gavage	IRIS, HEA
Carbon tetrachloride	1.3E-01	B2	Liver	Gavage	IRIS
Carcinogenic PAHs (g) (Benzo[a]pyrene)	1.15E+01	B2	Forestomach	Gavage	(e)
Chloroform	6.1E-03	B2	Kidney	Water	IRIS
Dibromochloromethane	8.4E-02	B2	Liver	Gavage	IRIS, HEA
Heptachlor	4.5E+00	B2	Liver	Diet	IRIS
Methylene chloride	7.5E-03	B2	Liver	Ing. & Water	IRIS
N-nitrosodiphenylamine	4.9E-03	B2	Urinary/Bladder	Diet	IRIS
Styrene	2.47E+00	C	Lung	Gavage	IRIS, HEA
Tetrachloroethene	5.1E-02	B2	Liver	Gavage	IRIS, HEA
Trichloroethene	1.10E-02	B2	Liver	Gavage	HA, HEAST
Vinyl chloride	2.3E+00	A	Lung	Ingestion	HEA
Inorganics:					
Arsenic	2.0E+00	A	Skin	Water	(f)
Beryllium	4.3E+00	B2	General	Water	IRIS
INHALATION (h)					
Organics:					
Benzene	2.9E-02	A	Blood	Inhalation	IRIS
Bromoform	3.9E-03	B2	Intestinal	--	IRIS
Carbon tetrachloride	1.3E-01	B2	Liver	Gavage	IRIS
1,1-Dichloroethene	1.2E+00	C	Kidney	Inhalation	IRIS
Methylene chloride	1.4E-02	B2	Liver/Lung	Inhalation	IRIS
Vinyl chloride	2.95E-01	A	Liver	Inhalation	HEA

-- = No available data.

(a) Toxicity criteria are not available for chloroethane; 2,4-dimethylphenol; di-n-octylphthalate; vinyl acetate; aluminium; calcium; cobalt; iron; lead; magnesium; potassium; sodium; and chloride.
(b) EPA weight of evidence classification scheme for carcinogens: A--Human Carcinogen, sufficient evidence from human epidemiological studies; B1--Probable Human Carcinogen, limited evidence from epidemiological studies and adequate evidence from animal studies; B2--Probably Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; C--Possible Human Carcinogen, limited evidence in animals in the absence of human data; D--Not Classified as to human carcinogenicity; and E--Evidence of noncarcinogenicity.
(c) Type(s) of cancer identified for Class A carcinogens only.
(d) IRIS = the chemical files of EPA's Integrated Risk Information System (as of 03/01/90); HEA = Health Effects Assessment Summary Tables (January/April 1990); HA = Health Advisory (Office of Drinking Water).
(e) Health Effects Assessment for Benzo(a)pyrene. 1984. Environmental Criteria and Assessment Office. Cincinnati, Ohio. September 1984. EPA 540/1-86/022.
(f) EPA 1988. Special Report on Ingested Inorganic Arsenic. Skin Cancer; Nutritional Essentiality. Risk Assessment Forum, Washington, D.C. EPA/625/3-87-013F. July 1988.
(g) For this chemical mixture, toxicity data for one of the most toxic compounds in the mixture, benzo(a)pyrene, is used to represent the entire mixture.
(h) Toxicity criteria are not available for acetone, bromodichloromethane, carbon disulfide, chloroethane, dibromochloromethane, 1,1-dichloroethane, 1,2-dichloroethane, ethylbenzine, toluene and xylenes.

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TABLE 15

RfD HEALTH EFFECTS CRITERIA FOR EXPOSURE TO CHEMICALS OF CONCERN
FULTZ LANDFILL SITE
FINAL RI REPORT

Chemical	Chronic RfD (mg/kg-day)	Uncertainty Factor (a)	Target Organ (b)	RfD Basis (c)	RfD Source (d)
ORAL (e)					

Organics:					
1,1,1-Trichloroethane	9.0E-02	1,000	Liver	Inhalation	IRIS
1,1,2-Trichloroethane	4.0E-03	1,000	Blood Chemistry	Water	IRIS
1,1-Dichloroethane	1.0E-01	1,000	Kidney	Inhalation	HEA
1,1-Dichloroethene	9.0E-03	1,000	Liver	Water	IRIS
1,2-Dichloroethene (total) (f)					
trans-	2.0E-02	1,000	Blood	Water	IRIS
cis-	1.0E-02	100	Liver	Water	IRIS
1,4-Dichlorobenzene	1.0E-01	1,000	Liver, Kidney	Inhalation	HA
2-Butanone (MEK)	5.0E-02	1,000	Neurotox, Fetal Tox.	Inhalation	IRIS
2-Methylphenol	5.0E-02	1,000	Weight, Neurotox	Gavage	IRIS
4-Methylphenol	5.0E-02	1,000	Weight, Neurotox	Gavage	IRIS
4-Methyl-2-pentanone	5.0E-02	1,000	Liver, Kidney	Gavage	IRIS
Acetone	1.0E-01	1,000	Liver, Kidney	Gavage	IRIS
Benzoic acid	4.0E+00		Malaise, Irritation	Diet-Human	IRIS
Benzyl alcohol	3.0E-01	1,000	Gastrointestinal	Gavage	HEA
bis(2-Ethylhexyl)phthalate	2.0E-02	1,000	Liver	Diet	IRIS
Bromodichloromethane	2.0E-02	1,000	Kidney	Gavage	IRIS, HEA
Bromoform	2.0E-02	1,000	Liver	Gavage	IRIS
Butylbenzylphthalate	2.0E-01	1,000	Weight, Liver, Kidney	Diet	IRIS
Carbon tetrachloride	7.0E-04	1,000	Liver	Gavage	IRIS
Chlorobenzene	2.0E-02	1,000	Liver, Kidney	Capsule	IRIS
Chloroform	1.0E-02	1,000	Liver	Food	IRIS
cis-1,3-Dichloropropene	3.0E-04	10,000	Nasal Organ Weight	Inhalation Diet	IRIS
Dibromochloromethane	2.0E-02	1,000	Liver	Gavage	IRIS, HEA
Diethylphthalate	8.0E-01	1,000	Weight	Diet	IRIS
Di-n-butylphthalate	1.0E-01	1,000	Mortality	Diet	IRIS
Ethylbenzene	1.0E-01	1,000	Liver, Kidney	Gavage	IRIS
Heptachlor	5.0E-04	300	Liver	Diet	IRIS
Methylene chloride	6.0E-03	100	Liver	Water	IRIS
Noncarcinogenic PAHs (f) (Naphthalene)	4.0E-03	1,000	Eye, Gastro-intestinal	Diet	HEA
Pentachlorophenol	3.0E-02	100	Liver, Kidney	Gavage	IRIS
Phenol	6.0E-01	100	Fetal Weight	Gavage	IRIS
Styrene	2.0E-01	1,000	Blood, Liver	Gavage	IRIS, HEA
Tetrachloroethene	1.0E-02	1,000	Liver	Gavage	IRIS, HEA
Toluene	3.0E-01	100	Neurotoxicity	Gavage	IRIS
trans-1,3-Dichloropropene	3.0E-04	10,000	Nasal Organ Weight	Inhalation Diet	IRIS
Trichloroethene	7.35E-03	1,000	Liver	Inhalation	HA, HEAST
Xylenes (total)	2.0E+00	100	Neurotox, Nasal, Throat Weight, Hyper-activity	Inhalation Gavage	IRIS
Inorganics:					
Antimony	4.0E-04	1,000	Blood Chemistry	Water	IRIS
Arsenic	1.0E-03	1	Skin	Water	HEA, EPA 1988
Barium	5.0E-02	100	Blood	Water	IRIS
Beryllium	5.0E-03	100	Blood, Skin	Water	IRIS
Cadmium	1.0E-03 food (g)	10	Kidney	Human	IRIS
Cadmium	5.0E-04 water	10	Kidney	Human	IRIS
Chromium	1.0E+00 III	1,000	Liver	Diet	IRIS
Chromium	5.0E-03 VI	500	Liver, Kidney	Water	
Copper (i)	3.7E-02	--	Gastrointestinal	Human Oral	HEA
Cyanide	2.0E-02	500	Weight, Thyroid	Diet	IRIS
Manganese	2.0E-01	100	Neurotoxicity	Inhalation, Water	HEA

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TABLE 15 (continued)

RfD HEALTH EFFECTS CRITERIA FOR EXPOSURE TO CHEMICALS OF CONCERN
FULTZ LANDFILL SITE
FINAL RI REPORT

Chemical	Chronic RfD (mg/kg-day)	Uncertainty Factor (a)	Target Organ (b)	RfD Basis (c)	RfD Source (d)
Inorganics (continued):					
Mercury (mercurial)	3.0E-04	1,000	Kidney	Diet	HEA
Nickel	2.0E-02	300	Organ Weight	Diet	IRIS
Selenium	3.0E-03	15	Skin	Food	HEA
Silver	3.0E-03	2	Argyria (skin)	Drug	IRIS
Thallium	7.0E-05	3,000	Blood Chemistry	Gavage	HEA
Vanadium	7.0E-03	100	Skin	Water	HEA
Zinc	2.0E-01	10	Blood	Drug	HEA
INHALATION (i)					
Organics:					
Carbon disulfide	1.0E-01	100	Fetal Tox.	Inhalation	IRIS
Chlorobenzene	5.0E-03	10,000	Liver & Kidney	Inhalation	HEA
1,1-Dichloroethane	1.0E+00	1,000	Kidney	Inhalation	HEA
Methylene chloride	8.6E-01 (j)	100	Liver	Inhalation	HEA
Toluene	5.7E-01 (j)	100	CNS	Inhalation	HEA
Xylenes	8.6E-02 (j)	100	CNS	Inhalation	HEA

-- = No available data.

(a) Uncertainty factors are the products of uncertainty adjustments and modifying factors. Uncertainty adjustments used to develop reference doses generally consist of multiples of 10, with each adjustment representing a specific area of uncertainty in the data available. The standard uncertainty adjustments include the following:
- a 10-fold factor to account for the variation in sensitivity among the members of the human population;
- a 10-fold factor to account for the uncertainty in extrapolating animal data to the case of humans;
- a 10-fold factor to account for the uncertainty in extrapolating from less-than-chronic NOAELs to chronic NOAELs; and
- a 10-fold factor to account for the uncertainty in extrapolating from LOAELs to NOAELs.

Modifying factors are applied at the discretion of the reviewer to cover other uncertainties in the data.

(b) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.

(c) Route of exposure in toxicity study upon which toxicity criterion is based.

(d) IRIS = the chemical files of EPA's Integrated Risk Information System (as of 03/01/90); HEA = Health Effects Assessment Summary.

(e) Toxicity criteria are not available for chloroethane; 2,4-dimethylphenol; di-n-octylphthalate; vinyl acetate; aluminum; calcium; cobalt; iron; lead; magnesium; potassium; sodium; and chloride.

(f) For these chemicals mixtures, toxicity data for one of the most toxic compounds in the mixture is used to represent the entire mixture, e.g., naphthalene for noncarcinogenic PAHs and cis-1,2-dichloroethene for 1,2-dichloroethene (total). In addition, chromium VI toxicity data is used for chromium.

(g) In accordance with EPA guidance, the cadmium RfD for food is used for food (i.e., fish) and other nonaqueous materials (i.e., soil).

(h) This is the current drinking water standard for copper which is based on local GI irritation. The Drinking Water Criteria Document concluded that the toxic data were inadequate for calculations of a verified RfD for copper. Health Effects Assessment Summary Table, Environmental Criteria and Assessment Office, Cincinnati, Ohio.

(i) Toxicity criteria are not available for acetone; bromodichloromethane, bromoform, dibromochloromethane; 1,2-dichloroethane; and ethylbenzene.

(j) Calculated chronic RfD based on a dose of 3 mg/m3 (methylene chloride), 2 mg/m3 (toluene), 0.3 mg/m3 (xylenes) and and an inhalation rate of of 20 mg/m3 for a 70 kg adult.

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TABLE 16

LEAD UPTAKE AND BLOOD LEAD LEVEL ESTIMATES (a)
FULTZ LANDFILL SITE
FINAL RI REPORT

Source of Exposure	Lead Uptake for the RME Case (ug/day)	Blood Lead Level for the RME Case (ug/dl)
Inhalation	0.11	0.04
Diet (b)	5.5	2.2
Direct Contact with Soil and Dust	0.002	0.0008
Direct Contact with Sediment	0.010	0.004
Ingestion of Groundwater		
Shallow Aquifer	32	13
Deep Aquifer	9.6	3.9
Total Lead Intake		
Shallow Aquifer	38	15
Deep Aquifer	15	6.1
Maternal Blood Lead	---	0.71
Total Blood Lead (c)		
Current Site Use Conditions:	---	3.0
Future Site Use Conditions:		
Shallow Aquifer	---	16
Deep Aquifer	---	7.0

(a) Blood lead levels calculated using Integrated Biokinetic/Uptake Model from EPA (1989c).
(b) Includes ingestion of drinking water containing background lead concentrations up to 16 ug/l.
(c) Current site use conditions include all pathways except ingestion of groundwater from the shallow or coal mine aquifer. Two pathway combinations are evaluated for future site use conditions, one including ingestion of groundwater from the shallow aquifer plus all other pathways, and one including ingestion of groundwater from the coal mine aquifer plus all other pathways.

--- = Not applicable.

TABLE 17

EXPOSURES AND RISKS TO CHILDREN AND TEENAGERS FROM INCIDENTAL DIRECT CONTACT WITH STREAM A SEDIMENTS
FULTZ LANDFILL SITE
FINAL RI REPORT

Potential Carcinogenic Effects

Sample Location	Chemical	RME Estimated Chronic Daily Intake (CDI) (a) (mg/kg-day) Incidental Ingestion	Dermal Absorption	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)		Excess Upper Bound Lifetime Cancer Risk (d)
POND 1:	Bis(2-ethylhexyl)phthalate	3.0E-08	1.6E-07	1.4E-02	B2		3E-09
	Bromodichloromethane	2.3E-10	2.1E-09	1.3E-01	B2		3E-10
						TOTAL:	3E-09
POND 1A:	Benzene	2.0E-09	1.8E-08	2.9E-02	A		6E-10
	Bromodichloromethane	9.4E-10	8.4E-09	1.3E-01	B2		1E-09
	Chloroform	2.5E-09	2.2E-08	6.1E-03	B2		1E-10
	Dibromochloromethane	7.0E-10	6.3E-09	8.4E-02	B2		6E-10
	1,1-Dichloroethane	2.1E-09	1.9E-08	9.1E-02	B2		2E-09
	1,1-Dichloroethene	2.1E-09	1.9E-08	6.0E-01	C		1E-08
	1,2-Dichloropropane	1.9E-09	1.7E-08	6.8E-02	B2		1E-09
	Styrene	1.4E-09	1.3E-08	2.47E+00	C		3E-08
	Tetrachloroethene	2.3E-09	2.1E-08	5.1E-02	B2		1E-09
	1,1,2-Trichloroethane	1.4E-09	1.3E-08	5.7E-02	C		8E-10
	Trichloroethene	1.9E-09	1.7E-08	1.1E-02	B2		2E-10
						TOTAL:	6E-08
POND 3:	Bis(2-ethylhexyl)phthalate	9.4E-09	5.1E-08	1.4E-02	B2	TOTAL:	8E-10
DOWNSTR A:	Arsenic	5.1E-09	NC	2.0E+00	A		1E-08
	Chloroform	8.2E-10	7.4E-09	6.1E-03	B2		5E-11
						TOTAL:	1E-08

Potential Noncarcinogenic Effects

Sample Location	Chemical	RME Estimated Chronic Daily Intake (CDI) (a) (mg/kg-day) Incidental Ingestion	Dermal Absorption	Reference Dose (mg/kg-day) (e)	Target Organ (f)		CDI:RfD (g)
POND 1:	Bis(2-ethylhexyl)phthalate	2.1E-07	1.1E-06	2.0E-02	Liver		7E-05
	Bromodichloromethane	1.6E-09	1.5E-08	2.0E-02	Kidney		8E-07
	Chlorobenzene	3.5E-08	3.2E-07	2.0E-02	Liver, Kidney		2E-05
	Di-n-butylphthalate	7.0E-08	3.1E-07	1.0E-01	Mortality		4E-06
	Pentachlorophenol	3.2E-07	8.6E-07	3.0E-02	Liver, Kidney		4E-05
	Toluene	1.2E-07	1.1E-06	3.0E-01	Neurotoxicity		4E-06
	1,1,1-Trichloroethane	4.9E-09	4.4E-08	9.0E-02	Liver		5E-07
						HAZARD INDEX:	<1 (1E-04)
POND 1A:	1,1,1-Trichloroethane	2.1E-08	1.8E-07	9.0E-02	Liver		2E-06
	1,1,2-Trichloroethane	9.9E-09	8.8E-08	4.0E-03	Blood Chemistry		2E-05
	1,1-Dichloroethane	1.5E-08	1.3E-07	1.0E-01	Kidney		1E-06
	1,1-Dichloroethene	1.5E-08	1.3E-07	9.0E-03	Liver		2E-05
	1,2-Dichloroethene (total)	1.4E-08	1.3E-07	1.0E-02	Liver		1E-05
	Bromodichloromethane	6.6E-09	5.9E-08	2.0E-02	Kidney		3E-06
	Bromoform	3.3E-09	2.9E-08	2.0E-02	Liver		2E-06
	Carbon disulfide	2.2E-08	2.0E-07	1.0E-01	Fetal Toxicity		2E-06
	Chlorobenzene	6.3E-08	5.7E-07	2.0E-02	Liver, Kidney		3E-05
	Chloroform	1.7E-08	1.5E-07	1.0E-02	Liver		2E-05
	cis-1,3-Dichloropropene	5.7E-09	5.2E-08	3.0E-04	Nasal, Organ Weight		2E-04
	Dibromochloromethane	4.9E-09	4.4E-08	2.0E-02	Liver		2E-06
	Ethylbenzene	1.4E-08	1.3E-07	1.0E-01	Liver, Kidney		1E-06
	Styrene	9.9E-09	8.8E-08	2.0E-01	Blood, Liver		5E-07
	Tetrachloroethene	1.6E-08	1.5E-07	1.0E-02	Liver		2E-05
	Toluene	1.6E-08	1.4E-07	3.0E-01	Neurotoxicity		5E-07
	trans-1,3-Dichloropropene	5.7E-09	5.2E-08	3.0E-04	Nasal, Organ Weight		2E-04
	Trichloroethene	1.3E-08	1.2E-07	7.3E-03	Liver		2E-05
	Xylenes (total)	1.1E-08	1.0E-07	2.0E+00	Neurotox, Nasal, Weight		6E-08
						HAZARD INDEX:	<1 (5E-04)

TABLE 17 (continued)

EXPOSURES AND RISKS TO CHILDREN AND TEENAGERS FROM
INCIDENTAL DIRECT CONTACT WITH STREAM A SEDIMENTS
FULTZ LANDFILL SITE
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Potential Noncarcinogenic Effects

		RME Estimated Chronic Daily Intake (CDI) (a) (mg/kg-day)				
		Incidental Ingestion	Dermal Absorption	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
POND 2:	1,1,1-Trichloroethane	4.1E-09	3.7E-08	9.0E-02	Liver	5E-07
	Antimony	7.9E-09	NC	4.0E-04	Blood Chemistry	2E-05
	Chlorobenzene	3.9E-08	3.5E-07	2.0E-02	Liver, Kidney	2E-05
	Toluene	3.3E-09	2.9E-08	3.0E-01	Neurotoxicity	1E-07
					HAZARD INDEX:	<1 (4E-05)
POND 3:	1,1,1-Trichloroethane	6.6E-09	5.9E-08	9.0E-02	Liver	7E-07
	Bis(2-ethylhexyl)phthalate	6.6E-08	3.5E-07	2.0E-02	Liver	2E-05
	Chlorobenzene	5.3E-08	4.7E-07	2.0E-02	Liver, Kidney	3E-05
					HAZARD INDEX:	<1 (5E-5)
POND 4:	1,1,1-Trichloroethane	5.7E-09	5.2E-08	9.0E-02	Liver	6E-07
	Chlorobenzene	5.6E-08	5.0E-07	2.0E-02	Liver, Kidney	3E-05
	Di-n-butylphthalate	1.8E-07	8.1E-07	1.0E-01	Mortality	1E-05
					HAZARD INDEX:	<1 (4E-05)
POND 5:	1,1,1-Trichloroethane	8.2E-09	7.4E-08	9.0E-02	Liver	9E-07
	Chlorobenzene	7.1E-08	6.3E-07	2.0E-02	Liver, Kidney	4E-05
	Cyanide	3.0E-09	NC	2.0E-02	Weight, Thyroid	2E-07
	Mercury	2.5E-10	2.2E-09	3.0E-04	Kidney	8E-06
	Selenium	1.8E-09	NC	3.0E-03	Skin	6E-07
	Silver	5.3E-09	NC	3.0E-03	Argyria (skin)	2E-06
	Thallium	1.8E-09	NC	7.0E-05	Blood Chemistry	3E-05
					HAZARD INDEX:	<1 (7E-05)
DOWNSTR A:	Acetone	2.9E-07	2.6E-06	1.0E-01	Liver, Kidney	3E-05
	Arsenic	3.6E-08	NC	1.0E-03	Skin	4E-05
	Barium	3.8E-07	NC	5.0E-02	Blood	8E-06
	Cadmium	5.5E-09	NC	1.0E-03	Kidney	6E-06
	Chloroform	5.7E-09	5.2E-08	1.0E-02	Liver	6E-06
	Manganese	1.2E-05	NC	2.0E-01	Neurotoxicity	6E-05
	Noncarcinogenic PAHs	4.0E-07	3.6E-06	4.0E-03	Eye, Gastrointestinal	1E-03
	Silver	4.2E-09	NC	3.0E-03	Argyria (skin)	1E-06
	Toluene	5.7E-09	5.2E-08	3.0E-01	Neurotoxicity	2E-07
					HAZARD INDEX:	<1 (1E-03)

(a) Presented previously in Section 6.3
(b) Presented previously in Table 6-41
(c) EPA weight of evidence classification scheme for carcinogens:
 A = Human Carcinogen, sufficient evidence from human epidemiological studies;
 B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
 C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

NC = Not Calculated. For inorganics, dermal absorption assumed to be negligible.

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TABLE 20

EXPOSURES AND RISKS TO INDIVIDUALS FROM THE
INGESTION OF GROUNDWATER FROM OFF-SITE RESIDENTIAL WELLS
FULTZ LANDFILL SITE
FINAL RI REPORT

Residential Well Number		RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)	Excess Upper Bound Lifetime Cancer Risk (d)
	Chemicals with Potential Carcinogenic Effects				
RW001:	Arsenic	6.1E-05	2.0E+00	A	1E-04
RW002:	Bromodichloromethane	1.5E-05	1.3E-01	B2	2E-06
	Dibromochloromethane	7.3E-06	8.4E-02	B2	6E-07
				TOTAL:	3E-06
RW003:	Arsenic	2.9E-04	2.0E+00	A	6E-04

Residential Well Number		RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
	Chemicals with Potential Noncarcinogenic Effects				
RW001:	Arsenic	1.4E-04	1.0E-03	Skin	1E-01
	Manganese	1.7E-02	2.0E-01	Neurotoxicity	8E-02
	HAZARD INDEX:				<1 (2E-01)
RW002:	Bromodichloromethane	3.4E-05	2.0E-02	Kidney	2E-03
	Dibromochloromethane	1.7E-05	2.0E-02	Liver	9E-04
	Manganese	1.6E-02	2.0E-01	Neurotoxicity	8E-02
	HAZARD INDEX:				<1 (8E-02)
RW003:	Arsenic	6.9E-04	1.0E-03	Skin	7E-01
	Barium	1.1E-02	5.0E-02	Blood	2E-01
	Manganese	8.0E-03	2.0E-01	Neurotoxicity	4E-02
	Zinc	6.3E-03	2.0E-01	Blood	3E-02
	HAZARD INDEX:				=1 (1E+00)
RW005:	Barium	5.0E-03	5.0E-02	Blood	1E-01
RW007:	Manganese	5.8E-04	2.0E-01	Neurotoxicity	3E-03

(a) Presented previously in Section 6.3
(b) Presented previously in Table 6-41
(c) EPA weight of evidence classification scheme for carcinogens:
 A = Human Carcinogen, sufficient evidence from human epidemiological studies;
 B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
 C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

TABLE 21

EXPOSURES AND RISKS TO CHILDREN AND TEENAGERS FROM INCIDENTAL DIRECT CONTACT WITH LEACHATE WATER
FULTZ LANDFILL SITE
FINAL RI REPORT

Potential Carcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)	Excess Upper Bound Lifetime Cancer Risk (d)
Organic Chemicals:				
Benzene	5.9E-08	2.9E-02	A	2E-09
Bis(2-ethylhexyl)phthalate	8.9E-08	1.4E-02	B2	1E-09
N-Nitrosodiphenylamine	9.1E-08	4.9E-03	B2	4E-10

TOTAL				3E-09

Potential Noncarcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
Organic chemicals:				
2-Methylphenol	9.0E-07	5.0E-02	Weight, Neurotox	2E-05
4-Methylphenol	8.0E-07	5.0E-02	Weight, Neurotox	2E-05
Acetone	2.0E-06	1.0E-01	Liver, Kidney	2E-05
Benzyl alcohol	7.4E-07	3.0E-01	Gastrointestinal	2E-06
Bis(2-ethylhexyl)phthalate	6.2E-07	2.0E-02	Liver	3E-05
Chlorobenzene	8.5E-07	2.0E-02	Liver, Kidney	4E-05
Diethylphthalate	3.2E-07	8.0E-01	Weight	4E-07
Ethylbenzene	1.9E-06	1.0E-01	Liver, Kidney	2E-05
Noncarcinogenic PAHs	5.3E-07	4.0E-03	Eye, Gastrointestinal	1E-04
Phenol	7.8E-07	6.0E-01	Fetal Weight	1E-06
Toluene	1.3E-06	3.0E-01	Neurotoxicity	4E-06
Xylenes (total)	1.7E-06	2.0E+00	Neurotox, Nasal, Weight	8E-07
Inorganic chemicals:				
Barium	9.1E-05	5.0E-02	Blood	2E-03
Chromium	4.5E-05	5.0E-03	Liver, Kidney	9E-03
Manganese	3.7E-04	2.0E-01	Neurotoxicity	2E-03

HAZARD INDEX				<1 (1E-02)

(a) Presented previously in Section 6.3
(b) Presented previously in Table 6-41
(c) EPA weight of evidence classification scheme for carcinogens:
  A = Human Carcinogen, sufficient evidence from human epidemiological studies;
  B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
  C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

TABLE 22

EXPOSURES AND RISKS TO CHILDREN AND TEENAGERS FROM
INCIDENTAL DIRECT CONTACT WITH LEACHATE SEDIMENTS
FULTZ LANDFILL SITE
FINAL RI REPORT

Potential Carcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (a) (mg/kg-day) Incidental Ingestion	Dermal Absorption	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)	Excess Upper Bound Lifetime Cancer Risk (d)
Organic Chemicals:					
1,4-Dichlorobenzene	2.1E-08	1.9E-07	2.4E-02	B2	5E-09
3,3-Dichlorobenzidene	7.0E-08	6.3E-07	4.5E-01	B2	3E-07
Bis(2-ethylhexyl)phthalate	2.4E-08	1.3E-07	1.4E-02	B2	2E-09
Carcinogenic PAHs	5.9E-09	2.1E-08	1.15E+01	B2	3E-07
Methylene chloride	6.5E-10	5.8E-09	7.5E-03	B2	5E-11
N-Nitrosodiphenylamine	1.2E-08	1.1E-07	4.9E-03	B2	6E-10
TOTAL					6E-07

Potential Noncarcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (a) (mg/kg-day) Incidental Ingestion	Dermal Absorption	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
Organic Chemicals:					
1,4-Dichlorobenzene	1.5E-07	1.3E-06	1.0E-01	Liver, Kidney	1E-05
Acetone	8.0E-09	7.2E-08	1.0E-01	Liver, Kidney	8E-07
Bis(2-ethylhexyl)phthalate	1.7E-07	9.1E-07	2.0E-02	Liver	5E-05
Butylbenzylphthalate	1.4E-07	6.3E-07	2.0E-01	Weight, Liver, Kidney	4E-06
Chlorobenzene	6.5E-09	5.8E-08	2.0E-02	Liver, Kidney	3E-06
Ethylbenzene	6.3E-09	5.7E-08	1.0E-01	Liver, Kidney	6E-07
Methylene chloride	4.5E-09	4.1E-08	6.0E-03	Liver	8E-06
Noncarcinogenic PAHs	2.2E-07	2.0E-06	4.0E-03	Eye, Gastrointestinal	5E-04
Toluene	6.2E-09	5.5E-08	3.0E-01	Neurotoxicity	2E-07
Xylenes (total)	4.4E-09	3.9E-08	2.0E+00	Neurotox, Nasal, Weight	2E-08
Inorganic Chemicals:					
Cyanide	4.1E-10	NC	2.0E-02	Weight, Thyroid	2E-08
Selenium	5.7E-10	NC	3.0E-03	Skin	2E-07
Silver	8.0E-10	NC	3.0E-03	Argyria (skin)	3E-07
Thallium	4.5E-10	NC	7.0E-05	Blood Chemistry	6E-06
HAZARD INDEX					<1 (6E-04)

(a) Presented previously in Section 6.3
(b) Presented previously in Table 6-41
(c) EPA weight of evidence classification scheme for carcinogens:
A = Human Carcinogen, sufficient evidence from human epidemiological studies;
B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

NC = Not Calculated. For inorganics, dermal absorption assumed to be negligible.

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TABLE 24

EXPOSURES AND RISKS TO HYPOTHETICAL RESIDENT FROM
INCIDENTAL DIRECT CONTACT WITH SOIL
FULTZ LANDFILL SITE
FINAL RI REPORT

Potential Carcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (a) (mg/kg-day) Incidental Ingestion	Dermal Absorption	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)	Excess Upper Bound Lifetime Cancer Risk (d)
Organic Chemicals:					
Methylene chloride	4.0E-09	2.3E-08	7.5E-03	B2	2E-10
Tetrachloroethene	1.3E-09	7.5E-09	5.1E-02	B2	4E-10
TOTAL					7E-10

Potential Noncarcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (a) (mg/kg-day) Incidental Ingestion	Dermal Absorption	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
Organic Chemicals:					
Acetone	9.3E-09	5.4E-08	1.0E-01	Liver, Kidney	6E-07
Di-n-butylphthalate	2.8E-07	8.1E-07	1.0E-01	Mortality	1E-05
Methylene chloride	9.3E-09	5.4E-08	6.0E-03	Liver	1E-05
Tetrachloroethene	3.0E-09	1.7E-08	1.0E-02	Liver	2E-06
Toluene	5.8E-09	3.3E-08	3.0E-01	Neurotoxicity	1E-07
HAZARD INDEX					<1 (2E-05)

(a) Presented previously in Section 6.3
(b) Presented previously in Table 6-41
(c) EPA weight of evidence classification scheme for carcinogens:
   A = Human Carcinogen, sufficient evidence from human epidemiological studies;
   B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
   C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

TABLE 23

EXPOSURES AND RISKS TO NEARBY RESIDENTS FROM THE
INHALATION OF AIRBORNE CONTAMINANTS
FULTZ LANDFILL SITE
FINAL RI REPORT

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)	Excess Upper Bound Lifetime Cancer Risk (d)
Chemicals with Potential Carcinogenic Effects				
Benzene	3.9E-03	2.9E-02	A	1E-04

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
Chemicals with Potential Noncarcinogenic Effects				
Toluene	1.1E-03	5.7E-01	Neurotoxicity	<1 (2E-03)

(a) Presented previously in Section 6.3
(b) Presented previously in Table 6-41
(c) EPA weight of evidence classification scheme for carcinogens:
A = Human Carcinogen, sufficient evidence from human epidemiological studies;
B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

TABLE 25

EXPOSURES AND RISKS TO FUTURE RESIDENTS FROM THE INGESTION OF GROUNDWATER FROM SHALLOW AQUIFER
FULTZ LANDFILL SITE
FINAL RI REPORT

Potential Carcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)	Excess Upper Bound Lifetime Cancer Risk (d)
Organics:				
1,1-Dichloroethene	3.4E-05	6.0E-01	C	2E-05
Benzene	1.2E-05	2.9E-02	A	4E-07
Bis(2-ethylhexyl)phthalate	9.7E-05	1.4E-02	B2	1E-06
Carcinogenic PAHs	4.7E-05	1.15E+01	B2	5E-04
Methylene chloride	1.2E-05	7.5E-03	B2	9E-08
N-Nitrosodiphenylamine	2.4E-05	4.9E-03	B2	1E-07
Vinyl chloride	5.8E-05	2.3E+00	A	1E-04
Inorganics:				
Arsenic	2.3E-04	2.0E+00	A	5E-04
Beryllium	7.1E-05	4.3E+00	B2	3E-04
TOTAL				1E-03

Potential Noncarcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
Organic chemicals:				
1,1-Dichloroethene	8.0E-05	9.0E-03	Liver	9E-03
1,2-Dichloroethene (total)	7.7E-05	1.0E-02	Liver	8E-03
2-Butanone	1.5E-04	5.0E-02	Neurotox, Fetal tox	3E-03
4-Methyl-2-pentanone	1.5E-04	5.0E-02	Liver, Kidney	3E-03
Acetone	1.5E-04	1.0E-01	Liver, Kidney	2E-03
Benzoic acid	2.9E-05	4.0E+00	Malaise	7E-06
Bis(2-ethylhexyl)phthalate	2.3E-04	2.0E-02	Liver	1E-02
Butylbenzylphthalate	5.7E-05	2.0E-01	Weight, Liver, Kidney	3E-04
Carbon disulfide	5.7E-05	1.0E-01	Fetal tox	6E-04
Chlorobenzene	7.7E-05	2.0E-02	Liver, Kidney	4E-03
Diethylphthalate	1.9E-04	8.0E-01	Weight	2E-04
Ethylbenzene	4.6E-05	1.0E-01	Liver, Kidney	5E-04
Methylene chloride	2.9E-05	6.0E-03	Liver	5E-03
Noncarcinogenic PAHs	1.3E-03	4.0E-03	Eye, Gastrointestinal	3E-01
Pentachlorophenol	6.0E-05	3.0E-02	Liver, Kidney	2E-03
Toluene	8.0E-05	3.0E-01	Neurotox	3E-04
Xylenes (total)	8.3E-05	2.0E+00	Neurotox, Weight, Nasal	4E-05
Inorganic chemicals:				
Antimony	5.7E-04	4.0E-04	Blood Chemistry	1E+00
Arsenic	5.4E-04	1.0E-03	Skin	5E-01
Barium	2.0E-02	5.0E-02	Blood	4E-01
Beryllium	1.6E-04	5.0E-03	Blood, Skin	3E-02
Cadmium	1.5E-04	5.0E-04	Kidney	3E-01
Chromium	2.6E-03	5.0E-03	Liver, Kidney	5E-01
Copper	2.7E-03	3.7E-02	Gastrointestinal	7E-02
Manganese	1.2E-01	2.0E-01	Neurotox	6E-01
Mercury	2.9E-05	3.0E-04	Kidney	1E-01
Nickel	3.5E-03	2.0E-02	Organ Weight	2E-01
Selenium	9.1E-05	3.0E-03	Skin	3E-02
Silver	8.6E-05	3.0E-03	Argyria (skin)	3E-02
Thallium	1.1E-04	7.0E-05	Blood Chemistry	2E+00
Vanadium	2.7E-03	7.0E-03	Skin	4E-01
Zinc	1.1E-02	2.0E-01	Blood	6E-02
HAZARD INDEX				>1 (7E+00)

TABLE 25 (continued)

EXPOSURES AND RISKS TO FUTURE RESIDENTS FROM THE INGESTION OF GROUNDWATER FROM SHALLOW AQUIFER
FULTZ LANDFILL SITE
FINAL RI REPORT

(a) Presented previously in Section 6.3
(b) Presented previously in Table 6-41
(c) EPA weight of evidence classification scheme for carcinogens:
 A = Human Carcinogen, sufficient evidence from human epidemiological studies;
 B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
 C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

TABLE 26

EXPOSURES AND RISKS TO FUTURE RESIDENTS FROM THE INGESTION OF GROUNDWATER FROM THE DEEP MINE AQUIFER
FULTZ LANDFILL SITE
FINAL RI REPORT

Potential Carcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)	Excess Upper Bound Lifetime Cancer Risk (d)
Organics:				
Bis(2-ethylhexyl)phthalate	1.7E-03	1.4E-02	B2	2E-05
Vinyl chloride	8.6E-05	2.3E+00	A	2E-04
Inorganics:				
Beryllium	2.2E-04	4.3E+00	B2	9E-04
TOTAL				1E-03

Potential Noncarcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
Organics:				
1,2-Dichloroethene (total)	8.3E-05	1.0E-02	Liver	8E-03
2-Butanone	2.3E-04	5.0E-02	Neurotox, Fetal tox	5E-03
Acetone	3.6E-04	1.0E-01	Liver, Kidney	4E-03
Benzoic acid	8.8E-04	4.0E+00	Malaise	2E-04
Bis(2-ethylhexyl)phthalate	4.0E-03	2.0E-02	Liver	2E-01
Di-n-butylphthalate	1.3E-04	1.0E-01	Mortality	1E-03
Ethylbenzene	5.7E-05	1.0E-01	Liver, Kidney	6E-04
Noncarcinogenic PAHs	2.9E-05	4.0E-03	Eye, Gastrointestinal	7E-03
Toluene	8.6E-05	3.0E-01	Neurotox	3E-04
Xylenes (total)	5.7E-05	2.0E+00	Neurotox, Nasal, Weight	3E-05
Inorganics:				
Antimony	1.7E-03	4.0E-04	Blood Chemistry	4E+00
Barium	4.5E-02	5.0E-02	Blood	9E-01
Beryllium	5.1E-04	5.0E-03	Blood, Skin	1E-01
Cadmium	3.0E-04	5.0E-04	Kidney	6E-01
Chromium	9.9E-03	5.0E-03	Liver, Kidney	2E+00
Copper	1.5E-02	3.7E-02	Gastrointestinal	4E-01
Manganese	5.6E-01	2.0E-01	Neurotox	3E+00
Nickel	1.3E-02	2.0E-02	Organ Weight	7E-01
Vanadium	1.3E-02	7.0E-03	Skin	2E+00
Zinc	3.7E-02	2.0E-01	Blood	2E-01
HAZARD INDEX				>1 (1E+01)

(a) Presented previously in Section 6.3.
(b) Presented previously in Table 6-41.
(c) EPA weight of evidence classification scheme for carcinogens:
A = Human Carcinogen, sufficient evidence from human epidemiological studies;
B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42.
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

TABLE 27

EXPOSURES AND RISKS TO FUTURE RESIDENTS FROM INHALATION WHILE SHOWERING WITH GROUNDWATER FROM THE SHALLOW AQUIFER
FULTZ LANDFILL SITE
FINAL RI REPORT

Potential Carcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)	Excess Upper Bound Lifetime Cancer Risk (d)
1,1-Dichloroethene	5.8E-05	1.2E+00	C	7E-05
Benzene	2.2E-05	2.9E-02	A	6E-07
Methylene chloride	2.1E-05	1.4E-02	B2	3E-07
Vinyl chloride	1.1E-04	2.9E-01	A	3E-05

Total				1E-04

Potential Noncarcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
Chlorobenzene	1.2E-04	5.0E-03	Liver, Kidney	2E-02
Methylene chloride	4.8E-05	8.6E-01	Liver	6E-05
Toluene	1.4E-04	5.7E-01	CNS	2E-04
Xylenes (total)	1.3E-04	8.6E-02	CNS	2E-03

Hazard Index				<1 (2E-02)

(a) Presented previously in Section 6.3
(b) Presented previously in Table 6-41
(c) EPA weight of evidence classification scheme for carcinogens:
A = Human Carcinogen, sufficient evidence from human epidemiological studies;
B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

TABLE 28

EXPOSURES AND RISKS TO FUTURE RESIDENTS FROM INHALATION WHILE SHOWERING WITH GROUNDWATER FROM THE DEEP AQUIFER
FULTZ LANDFILL SITE
FINAL RI REPORT

Potential Carcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Slope Factor (mg/kg-day)-1 (b)	Weight of Evidence Class (c)	Excess Upper Bound Lifetime Cancer Risk (d)
Vinyl chloride	1.7E-04	2.9E-01	A	5E-05

Potential Noncarcinogenic Effects

Chemical	RME Estimated Chronic Daily Intake (CDI) (mg/kg-day) (a)	Reference Dose (mg/kg-day) (e)	Target Organ (f)	CDI:RfD (g)
Toluene	1.5E-04	5.7E-01	CNS	3E-04
Xylenes (total)	9.2E-05	8.6E-02	CNS	1E-03
Hazard Index				<1 (1E-03)

(a) Presented previously in Section 6.3
(b) Presented previously in Table 6-41
(c) EPA weight of evidence classification scheme for carcinogens:
A = Human Carcinogen, sufficient evidence from human epidemiological studies;
B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
(d) Calculated by multiplying the CDI by the slope factor.
(e) Presented previously in Table 6-42
(f) A target organ is the organ most sensitive to a chemical's toxic effect. RfDs are based on toxic effects in the target organ. If an RfD was based on a study in which a target organ was not identified, the organ listed is one known to be affected by the particular chemical of concern.
(g) Calculated by dividing the CDI by the RfD.

TABLE 29

SUMMARY OF UNCERTAINTIES IN THE BASELINE RISK ASSESSMENT
FULTZ LANDFILL SITE
FINAL RI REPORT

ASSUMPTION	MAGNITUDE OF EFFECT ON RISK (a)	DIRECTION OF EFFECT ON RISK
ENVIRONMENTAL SAMPLING AND ANALYSIS		
Potentially naturally occuring levels of inorganics and chemicals that may be associated with mining operations attributed to site.	Moderate	May over-estimate risk
Sufficient samples may not have been taken to characterize surface water, sediment, and off-site residential wells.	Low	May over- or under-estimate risk
Systematic or random errors in the chemical analyses may yield erroneous data.	Low	May over- or under-estimate risk
Chemical concentrations reported as "below the contract required quantitation limit (e.g., labled "U") are included as one-half the quantitation limit.	Low	May over- or under-estimate risk
EXPOSURE PARAMETER ESTIMATION		
The standard assumptions regarding body weight, period exposed, life expectancy, population characteristics, and lifestyle may not be representative of any actual exposure situation.	Moderate	Would tend to overestimate risk given the conservative assumptions used
The amount of media intake is assumed to be constant and representative of the exposed population.	Low	Would tend to overestimate risk given the conservative assumptions used
Concentrations of contaminants remain constant over exposure period	Moderate	Would tend to overestimate risk to most chemicals
Combining upperbound estimates of exposure parameters using a simple intake equation to estimate exposure to represent the RME.	Moderate	Would tend to overestimate exposure and risk
TOXICOLOGICAL DATA		
The cancer slope factors used are upper bound estimates.	High	May over-estimate risk
Risks are assumed to be additive. Risks may not be additive because of synergistic or antagonistic actions of other chemicals.	Low	May over- or under-estimate risk
Dose-response data were not available for all of the selected chemicals of potential concern.	Low	May under-estimate risk
Surrogate chemicals were selected to represent mixtures of chemicals in a class (e.g., carcinogenic PAHs).	Low	May over-estimate risk
Cancer risks were added across chemicals with different EPA weight-of-evidence classifications (e.g., adding risks for a Group A and a Group B2 carcinogen).	Moderate	May over-estimate risk

(a) As a general guideline, assumptions marked as "low", may affect estimates of of exposure by less than on order of magnitude; assumptions marked "moderate" may affect estimates of exposure by between one and two orders of magnitude; and assumptions marked "high" may affect estimates of exposure by more than two orders of magnitude.

TABLE 30

CONCENTRATIONS OF INORGANICS IN SURFACE WATER FROM STREAM A AND RECOMMENDED MAXIMUM DIETARY LEVELS FOR LIVESTOCK DRINKING WATER
FULTZ LANDFILL SITE
FINAL RI REPORT

(All concentrations in ug/L)

Chemical of Potential Concern	Concentrations in Surface Water Along Stream A							Maximum Level Recommended by PULs (1988)	Maximum Level Recommended by NAS (1980)
	Pond 1 (a)	Pond 1A	Pond 2	Pond 3	Pond 4	Pond 5	Downstream of Pond 5		
Aluminum	195	201	--	--	--	--	--	5,000	NA
Arsenic	2.9	3.4	2.7	2.2	--	--	--	200	50
Barium	--	--	--	--	--	--	84.8	1,000	NA
Cobalt	5.1	--	--	--	--	--	--	1,000	1,000
Copper	7.1	--	--	--	7.3	5.5	--	500	1,000
Manganese	824	339	626	485	146	251	1,530	50	NA
Nickel	13.9	--	--	--	--	--	--	NA	1,000

(a) Values presented are the arithmetic means of the sample and a duplicate sample.

-- = Not selected as a chemical of concern.
NA = Not available.

POOR QUALITY ORIGINAL

F-34-D

TABLE 31

MAJOR CONCLUSIONS OF THE BASELINE RISK ASSESSMENT
FULTZ LANDFILL SITE
FINAL RI REPORT

Exposure Pathway	Total Excess Lifetime Carcinogenic Risk RME Case	Non-Carcinogenic Hazard Index RME Case	Comments
Current Land Use			
Direct Contact with Sediments by Children and Teenagers			
Stream A: Pond 1	3E-09	<1 (1E-04)	
Pond 1A	6E-08	<1 (5E-04)	
Pond 2	---	<1 (4E-05)	
Pond 3	8E-10	<1 (5E-05)	
Pond 4	---	<1 (4E-05)	
Pond 5	---	<1 (7E-05)	
Downstream A	1E-08	<1 (1E-03)	
Wills Creek	1E-08	<1 (7E-05)	
Direct Contact with Surface Water by Children and Teenagers			
Stream A: Pond 1	9E-08	<1 (9E-04)	
Pond 1A	1E-07	<1 (5E-04)	
Pond 2	8E-08	<1 (6E-04)	
Pond 3	7E-08	<1 (5E-04)	
Pond 4	---	<1 (1E-04)	
Pond 5	---	<1 (1E-04)	
Downstream A	---	<1 (1E-03)	
Direct Contact with Soil by Children and Teenagers	4E-10	<1 (4E-05)	
Ingestion of and Inhalation while showering with Groundwater by Residents			
Byesville Water Supply			
Untreated	3E-05	<1 (3E-01)	Cancer risks in the untreated water associated with carbon tetrachloride which does not appear to be site related since it was not detected in any other groundwater sampled during the RI. Adverse noncarcinogenic effects unlikely to occur.
Treated	---	<1 (1E-01)	

TABLE 32

COST ESTIMATE SUMMARY

ALTERNATIVE 4-A - MULTI-LAYER CAP, GROUNDWATER EXTRACTION AND TREATMENT
(With Grout Pillars)

FULTZ LANDFILL SITE - FEASIBILITY STUDY REPORT

ITEM	Quantity	Capital Cost	Annual O & M	Present Worth O&M/Replacement 30 years, 5%	Present Worth O&M/Replacement 30 years, 10%
I. INSTITUTIONAL ACTIONS					
1. Deed Restrictions	NA	$10,000			
2. Public Education Program	NA	$20,000			
3. Institutional Controls	NA	$20,000			
4. Alternate Water Supply	$25	$117,000			
Subtotal:		$167,000			
II. GENERAL ACTIONS/SITE PREPARATION					
1. Site Fencing	10000 FT	$160,000	$8,000	$123,000	$75,000
2. Mobilization, Decon, Staging Area	NA	$131,000			
Subtotal:		$291,000	$8,000	$123,000	$75,000
III. MULTI-LAYER CAP					
1. Multi-Layer Cap Installation	22 acres	$5,771,000		$332,000	$173,000
2. Leachate Collection System	NA	$402,000			
3. Grout Pillars	NA	$900,000			
Subtotal:		$7,073,000		$286,000	$150,000
IV. WATER CONTROL					
1. Subsurface Diversion Ditch	1600 FT	$978,000			
2. Surface Water Diversion Ditch	1600 FT	$10,000			
3. Pond Excavations	NA	$495,000			
4. Erosion & Sediment Controls	NA	$174,000			
5. Wetlands Replacement	NA	$250,000			
Subtotal:		$1,907,000			
V. EXTRACTION AND ONSITE WATER TREATMEN					
1. Extraction Wells	12 Wells	$150,000	$15,000	$231,000	$141,000
2. Treatment Plant Building	NA	$350,000			
3. Treatment System	NA	$165,000	$103,000	$1,583,000	$971,000
4. Residual Disposal	NA		$7,000	$108,000	$66,000
Subtotal:		$665,000	$125,000	$1,922,000	$1,178,000
V. LONG-TERM MONITORING AND REVIEWS					
1. Monitoring Well Installation	5 wells	$40,000			
2. Environmental Sampling	*		$85,000	$1,307,000	$801,000
3. 5 Year Reviews	6 Reviews **			$83,000	$46,000
Subtotal:		$40,000	$85,000	$1,390,000	$847,000
CONSTRUCTION SUBTOTAL		$10,143,000	$218,000	$3,721,000	$2,250,000
Health and Safety 5%		$507,150			
Bid Contingency 10%		$1,014,300			
Scope Contingency 10%		$1,014,300			
CONSTRUCTION TOTAL		$12,678,800			
Permitting & Legal 5%		$633,940			
Services During Construction 8%		$1,014,304			
TOTAL IMPLEMENTATION COST		$14,327,000			
Engineering & Design 10%		$1,432,700			
TOTAL CAPITAL COSTS		$15,759,700			
TOTAL PRESENT WORTH				$19,480,700	$18,009,700

NA: NOT APPLICABLE

* Monitoring period of 30 years. Environmental sampling includes: surface water, leachate, sediment, and groundwater, all of which are sampled semi-annually.

** Present worth value of reviews based on current cost of $15,000/review. Reviews at t=5 yr, 10 yr, 15 yr, 20 yr, 25 yr, and 30 yr.

TABLE 31 (Continued)

MAJOR CONCLUSIONS OF THE BASELINE RISK ASSESSMENT
FULTZ LANDFILL SITE
FINAL RI REPORT

Exposure Pathway	Total Excess Lifetime Carcinogenic Risk RME Case	Non-Carcinogenic Hazard Index RME Case	Comments
Off-site Residential Wells			
RW001	1E-04	<1 (2E-01)	Cancer risks associated with arsenic, and bromodichloromethane. It is not clear whether these chemicals are site-related.
RW002	3E-06	<1 (8E-02)	
RW003	6E-04	=1 (1E+00)	
RW005	---	<1 (1E-01)	
RW007	---	<1 (3E-03)	
Direct Contact with Leachate Seeps by Children and Teenagers			
Leachate Water	3.0E-09	<1 (1E-02)	
Leachate Sediments	6.0E-07	<1 (6E-04)	
Inhalation of Airborne Contaminants by Nearby Residents	1.0E-04	<1 (2E-03)	Cancer risks associated with benzene which was only detected in one of seven samples and at a location not near any residents. Adverse noncarcinogenic effects unlikely to occur.
Future Land Use			
Direct Contact with Soil by Hypothetical Resident	7.0E-10	<1 (2E-05)	
Ingestion of and Inhalation While Showering with Groundwater			
Shallow Aquifer	1E-03	>1 (7E+00)	Cancer risks associated with bis(2-ethylhexyl)phthalate, 1,1-dichloroethene, carcinogenic PAHs, vinyl chloride, arsenic, and beryllium. Potential noncarcinogenic health effects are are driven primarily by antimony and thallium, both of which affect the blood chemistry.
Coal Mine Aquifer	1E-03	>1 (1E+01)	Cancer risks associated with bis(2-ethylhexyl)phthalate, vinyl chloride and beryllium. Adverse noncarcinogenic health effects are driven by antimony, chromium, manganese, and vanadium.

Attachment 1

Ohio Environmental Protection Agency - Letter of Concurrence

OhioEPA
State of Ohio Environmental Protection Agency

P.O. Box 1049, 1800 WaterMark Dr.
Columbus, Ohio 43266-0149
(614) 644-3020
FAX (614) 644-2329

George V. Voinovich
Governor

September 30, 1991

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

Dear Mr. Adamkus:

On September 24, 1991, I sent to you a letter indicating Ohio EPA's concurrence with the Record of Decision (ROD) for the Fultz Landfill Superfund site. It has come to my attention that, subsequent to my indication of State concurrence, your Office of Regional Counsel made changes in the ROD. As the ROD that I reviewed for concurrence has been modified, I must retract my letter of September 24, 1991.

My staff informs me that the changes made to the ROD do not substantively change the remedy. Consequently, the Ohio EPA hereby concurs with the revised final unsigned and undated ROD, a copy of which is enclosed herewith and incorporated herein by reference for identification purposes.

This concurrence should not be construed to mean that the Ohio EPA approves of the manner in which this ROD has been revised.

The Superfund Memorandum of Agreement (SMOA) entered into by the Ohio EPA and U.S. EPA specifies procedures by which RODs are developed and State concurrence is provided. Specifically, the SMOA dictates that a final ROD be submitted to the Ohio EPA for concurrence at the time that consensus or other formal agency position is reached. The formal Ohio EPA position on the final ROD is to be made by me in my capacity as Director. A ROD and a request for State concurrence was received by this Agency on September 20, 1991.

Accordingly, the September 19, 1991, request for State concurrence (attached) implied that consensus had been reached and the ROD was final. Rather, the decision documents were prematurely submitted to me, without the requisite consensus of the parties concerned, specifically, the Region 5 Office of Regional Counsel. Better coordination between our agencies in the future is necessary to ensure smoother finalization of RODs.

Sincerely,

Donald R. Schregardus
Director

DS/JAK/tdl

Enclosure

cc: Jenny Tiell, Chief-DERR, Ohio EPA
Jan Carlson, Assistant Chief-DERR, Ohio EPA
Don Vanterpool, Legal, Ohio EPA
Kathy Davidson, DERR, Ohio EPA
Tom Bloom, USEPA
Don Bruce, USEPA
Chris Vanecko, SEDO