REDACTED

27385

REMEDIAL SITE ASSESSMENT DECISION - EPA REGION IV

Site Name: Jefferson Forest Drum Site **EPA ID#:** KYD985112986

Alias Site Names: _____

City: _____ **County ~~or Parish~~:** Jefferson **State:** KY

Refer to Report Dated: _____ **Report type:** PA

Report developed by: BVWST

DECISION:

|✓| **1. Further Remedial Site Assessment under CERCLA (Superfund) is not required because:**

|✓| 1a. Site does not qualify for further remedial site assessment under CERCLA (No Further Remedial Action Planned - NFRAP)

| | 1b. Site may qualify for further action, but is deferred to: | | RCRA | | NRC

| | **2. Further Assessment Needed Under CERCLA:** 2a. (optional) Priority: | | Higher | | Lower

2b. Activity Type: | | PA | | ESI | | SI | | HRS evaluation

| | Other: _____

DISCUSSION/RATIONALE:

See attached comments.

Report Reviewed and Approved by: R. Klein **Signature:** Ramona J. Klein **Date:** 10-26-94

Site Decision Made by: R. Klein **Signature:** Ramona J. Klein **Date:** 10-26-94

EPA Form # 9100-3

VIEW EVENT COMMENTS

REF NO.: 05991 EPA ID: KYD985112986

OPUNIT: 00 SITE NAME: JEFFERSON FOREST DRUM

EVENT: PA1 EVENT NAME: PRELIMINARY ASSESSMENT

COMM ID	LINE NO.	COMMENTS	TYPE
001	01	10-26-94 KLEIN	
001	02	DRUM CARCASSES AND MISCELLANEOUS WASTE MATERAL OBSERVED ON	
001	03	SOIL EMBANKMENT AT SITE. NFRAP DUE TO LACK OF TARGETS.	

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DATE REPORT ACCEPTED 10-26-94
DISPOSITION NFRAP
SAM SIGNATURE Klein

Preliminary Assessment

Jefferson Forest Drum Site

Jefferson Memorial Forest, Jefferson County, KY
EPA ID № KYD985112986
WasteLAN № 05991

Prepared Under:
Contract № 68-W9-0055
For The
U.S. Environmental Protection Agency

Prepared By:
B&V Waste Science and Technology Corp.
BVWST Project № 52009.049

October 20, 1994

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RECD.
OCT 24 1994

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Jefferson Forest Drum Site
Jefferson Memorial Forest, Jefferson County, Kentucky
EPA ID Nº KYD985112986

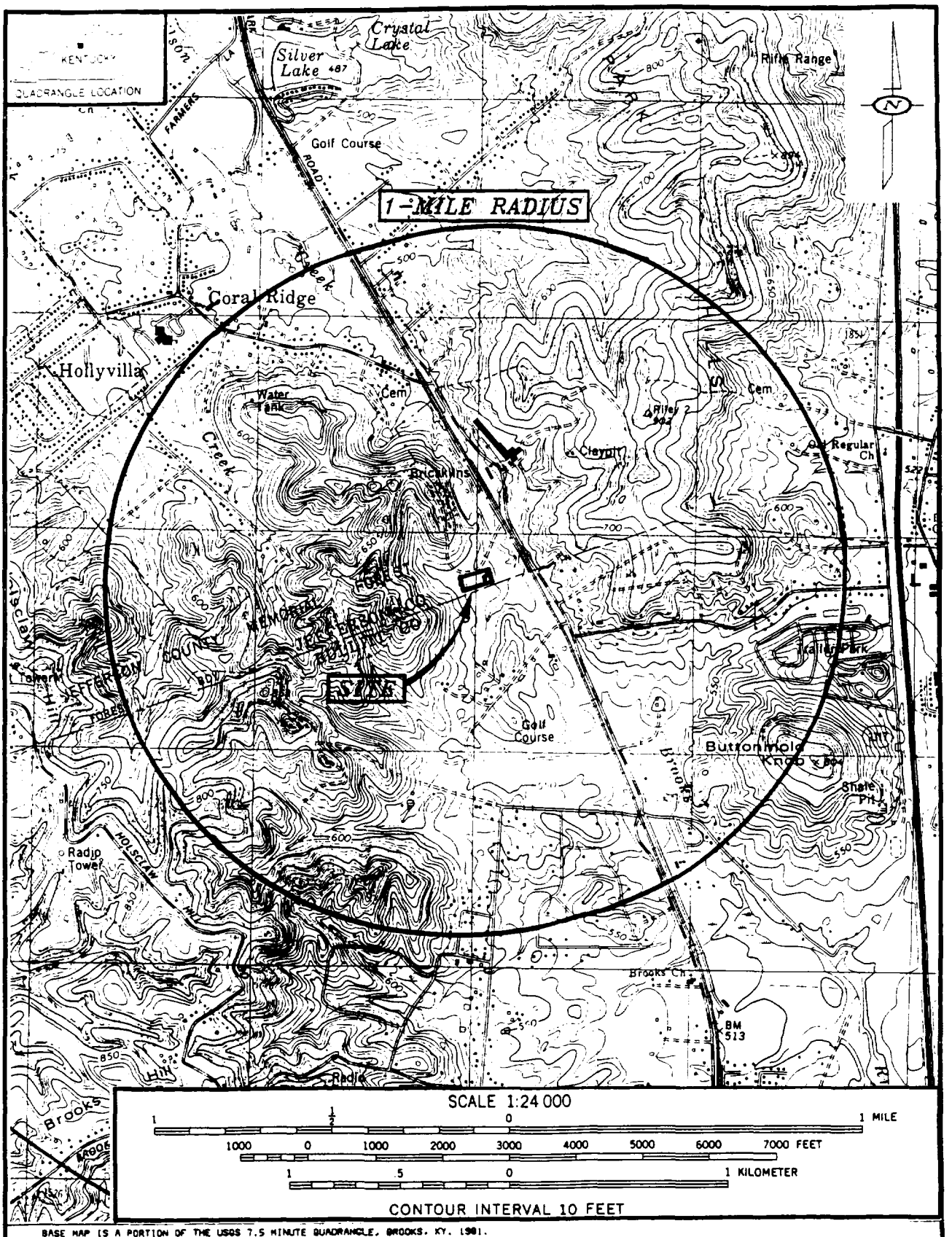
1.0 Introduction

The U.S. Environmental Protection Agency (EPA), Waste Management Division, Region IV, tasked B&V Waste Science and Technology Corp. (BVWST) to conduct a preliminary assessment (PA) of the Jefferson Forest Drum site (herein referred to as the "site"), located in the Jefferson Memorial Forest, Jefferson County, Kentucky. The PA was performed under the authorization of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendment Reauthorization Act of 1986 (SARA). The purpose of this assessment was to collect information concerning conditions at the site sufficient to assess the threat posed to human health and the environment and to determine the need for CERCLA/SARA enforcement or other appropriate actions. The scope of this assessment included a review of the available file information, a comprehensive target survey, and an onsite reconnaissance visit performed September 14, 1993.

2.0 Site Location, Description, Operational History, and Waste Characteristics

2.1 Site Location

The Jefferson Forest Drum site, shown on Figure 1, is located near the boundary of Jefferson and Bullitt Counties in Kentucky. The site lies within the Jefferson Memorial Forest, approximately ⅓ mile northwest of the intersection of Kentucky State Route (KSR) 1020 (Brooks Road) and Letts Road (Ref. 1). The site is geographically located at North latitude 38°05′5.6″ and West longitude 85°43′37.2″ (Ref. 2). Site relief varies from approximately 550 to 530 feet National Vertical Geodetic Datum (NVGD), 1927 (Ref. 1). The climate of the area is continental and variable, with moderately cold winters and warm summers. The average daily maximum and minimum temperatures vary from 41° F and 24° F in January to 88° F and 68° F in July. High intensity rainfall events are common during the spring and summer; precipitation is nonseasonal and varies from year to year. The average annual precipitation for the area is 43.56 inches (Ref. 3, p. 3). The mean annual lake



BASE MAP IS A PORTION OF THE USGS 7.5 MINUTE QUADRANGLE, BROOKS, KY. 1981.

SITE LOCATION MAP
JEFFERSON FOREST DRUM SITE
JEFFERSON FOREST, JEFFERSON COUNTY, KENTUCKY

FIGURE 1

evaporation (pan method) in this area is approximately 35 inches (Ref. 4, p. 63), yielding a net annual rainfall of 8.5 inches. The average 2-year, 24-hour rainfall event is 3.2 inches (Ref. 5, p. B-4).

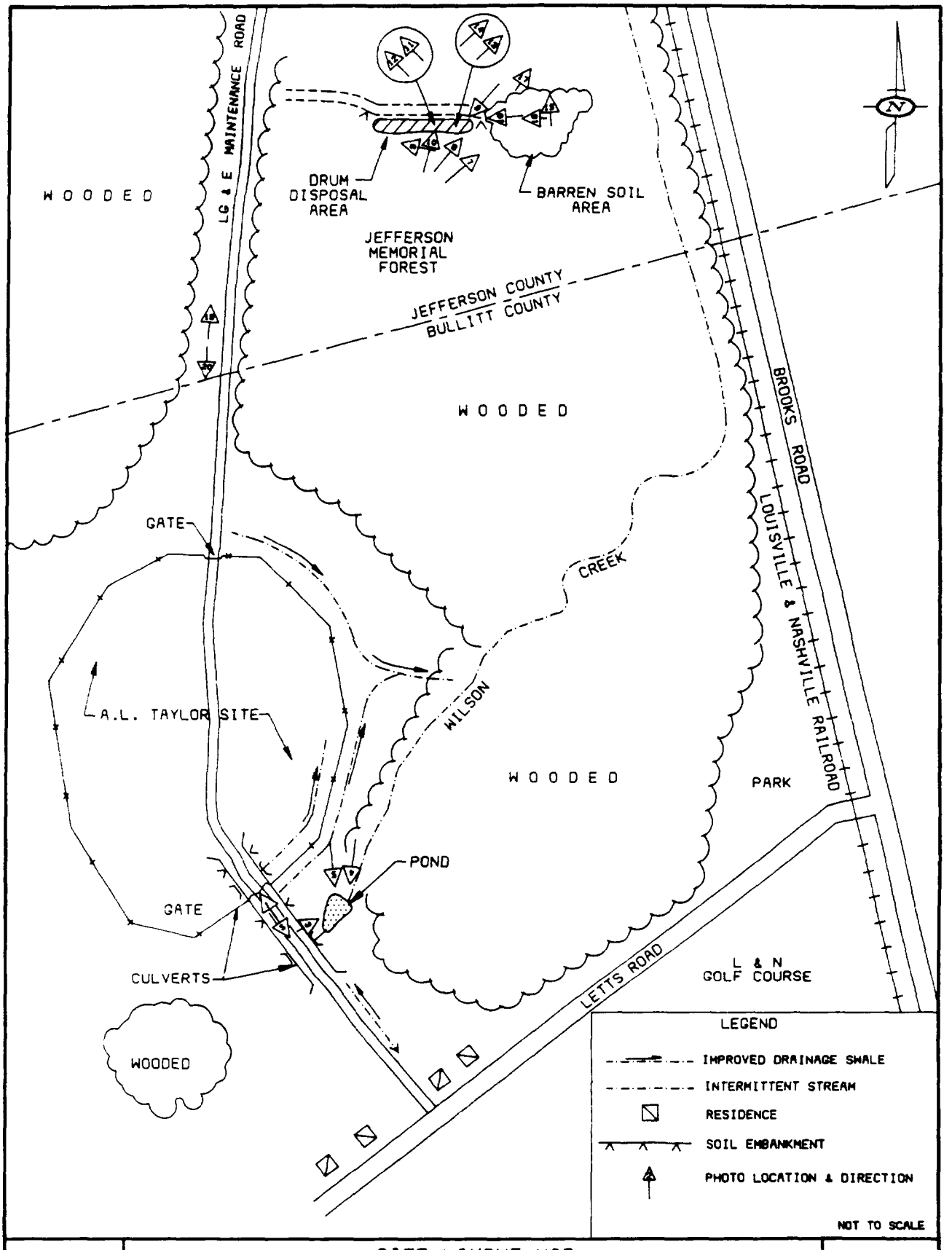
2.2 Site Description

The Jefferson Forest Drum Site, shown on Figure 2, is heavily wooded and lies entirely within the Jefferson Memorial Forest. The area is bounded by forested hills to the north; the Louisville and Nashville (L&N) railroad and KSR 1020 to the east; the A.L. Taylor Superfund site (EPA ID No. KYD980500961) and residential property to the south; and a Louisville Gas & Electric Co. (LG&E) maintenance road to the west (Refs. 6; 7). Access to the LG&E maintenance road is restricted northwest of Letts Road by a locked gate at the A.L. Taylor site perimeter fence (Appendix A, Photographs Nº 1 and Nº 2)(Ref. 6).

The adjacent A.L. Taylor site operated from 1967 to 1977 as a municipal refuse dump, a drum recycling center, and an industrial chemical dump. The actual disposal area covers 13 acres of an original 23-acre tract owned by the former operator. Pits were excavated on the A. L. Taylor site property (including the Wilson Creek Valley and the adjacent hillside), the drum contents were emptied into the pits, and the drums were recycled (Ref. 8, p. 1-1). During past removal activities, waste materials at ground surface (e.g., drummed liquid and solid wastes) were excavated. It is estimated, however, that 13,000 to 31,700 cubic yards of waste and contaminated soil remain buried at the A. L. Taylor site (Ref. 9, p. 1).

In June 1986, a Record of Decision was signed for the A. L. Taylor site that specified the selected remedial alternative for closure of the disposal area and remediation of adjacent drainage areas. This included installation of a clay soil cover for waste containment, construction of a surface water drainage/diversion system, installation of a perimeter fence, and implementation of a groundwater monitoring program and a performance monitoring program for adjacent Wilson Creek (Ref. 10, p. 8-9).

Wilson Creek is an intermittent stream that receives surface water runoff (overland flow) from the wooded hilly areas northeast and residential properties southeast of the A.L. Taylor site. Surface runoff from the residential properties is collected in a



SITE LAYOUT MAP
JEFFERSON FOREST DRUM SITE
JEFFERSON FOREST, JEFFERSON COUNTY, KENTUCKY

FIGURE 2

pond (Photographs Nº 3 and Nº 5) from which overflow is diverted to the headwaters of Wilson Creek (Photograph Nº 4). Flow only occurs in this upper reach of Wilson Creek during wet seasons (Ref. 9, p. 6).

The site is located northeast of the A.L. Taylor site along an infrequently used trail leading from a LG&E maintenance road (Photographs Nº 19 and Nº 20). The trailhead at the maintenance road is located near the third power-line pole beyond the A.L. Taylor site north gate (Refs. 6; 7). A soil embankment, approximately 200 feet in length, parallels the south side of the trail within a heavily wooded area east of the maintenance road (Ref. 6).

At the time of the site reconnaissance, the soil embankment was overgrown (Photograph Nº 6). However, debris was observed on the ground surface at the base of the embankment and buried within the embankment. Material observed at the base of the embankment included corroded drum carcasses and insulation-type material (Photograph Nº 7); a granular solidified grey to greenish-grey material (Photograph Nº 9); an amber glass laboratory or pharmaceutical vial (Photograph Nº 10); bricks (Photograph Nº 11); and a corroded 5-gallon container (Photograph Nº 12). Similar, but more extensive material was observed to have been disposed of within the soil embankment (Photograph Nº 15). Debris noted included drum carcasses, scrap metal, and solidified waste material (Photographs Nº 8, Nº 13, and Nº 14). A corroded 5-gallon container was also observed on the ground surface approximately 80 yards east of the soil embankment. None of the containers observed appeared to contain any free liquid nor was any leachate observed to be flowing from the soil embankment. An intermittent stream located south of the soil embankment appears to collect surface water runoff from this area (Ref. 6).

At the east end of the soil embankment (Photograph Nº 18), the wooded area opens into a clearing. The clearing is characterized by a barren soil area composed of loose soil and weathered rock (Photograph Nº 16). Immediately east of the soil embankment, the soil was observed to be eroded due to surface water runoff. Intense metal detector readings were noted during a November 1992 scan of a barren soil mound. This area was noted to be rutted from possible vehicle traffic (Ref. 6).

Although the site lies within the Jefferson Memorial Forest (Refs. 1; 7), no signage or demarcation was observed during the site reconnaissance. However, an overgrown fence was observed northeast of the site (Photograph Nº 17) (Ref. 6). Previous reports have documented the site may have been accessed by a road leading from the area of the brickyard located on KSR 1020 (Ref. 7). An attempt was made during the site reconnaissance to access the right-of-way to the L&N railroad and KSR 1020 from the site; however, no point of egress was found east of the barren soil area (Ref. 6). It has also been noted that A.L. Taylor may have owned a 100-acre parcel that includes the site and that the site may have been part of Mr. Taylor's original disposal operation (Ref. 7).

2.3 Operational History and Waste Characteristics

Historical file information on property ownership and disposal activities conducted at the site is limited. The site was only recently discovered by the Kentucky Department for Environmental Protection (KDEP). On November 13, 1992, KDEP personnel accompanied a nearby property owner who reported the previously unknown disposal area. The site is part of an approximately 100-acre parcel of land that was donated to the Jefferson Memorial Forest by the previous landowner (Refs. 7; 11). KDEP personnel documented 44 fully-exposed and partially-exposed 55-gallon drums, household appliances, and scrap metal disposed of within the previously described soil embankment. The drums were noted to be in poor condition; several drums were rusted through. One drum was observed to be leaking a small amount of fluid, while another corroded drum was found to contain liquid but was not leaking. Several hundred tubes of waterproof sealant and solidified white material were also observed within an area of construction debris fill material (Ref. 7).

KDEP investigators returned to the site on November 18, 1992, to conduct an ambient air volatile organic compounds (VOCs) scan and metal detection survey. Although no readings above background were recorded during the VOCs scan, intense magnetic readings were recorded during the metals detection survey over the barren soil mound and the fill area between the access road and the embankment (Ref. 7). On this same date, an additional portion of the soil embankment was

observed to have been used for disposal. This portion of the soil embankement was observed to contain drum carcasses, sealant tubes, and plastic buckets containing solidified white material (Ref. 7).

Under the Technical Assistance Team (TAT) contract, an investigation of the site was performed on February 10, 1993, to determine the extent of the drum disposal area (Ref. 12). Trees and brush were cleared from the soil embankment and piled on both ends of the planned excavation area. Exploratory excavation was performed along the length of the soil embankment. Excavation terminated at each point where debris was no longer present in the fill and native soil was apparently encountered. A 4-foot deep trench was also excavated at the top of the soil embankment. Slight surface debris overlying apparent native soil was observed. Metal debris was segregated from the empty drums excavated from the soil embankment. Twenty to 25 empty drums were crushed and stockpiled (Refs. 12; 13).

An additional 6-foot deep trench was excavated approximately 100 yards northeast of the soil embankment in an area where high magnetic readings were previously noted. No drums or other debris were observed during this excavation (Ref. 12).

Three drums containing liquid were sampled. The first drum contained approximately 7 gallons of a grey liquid that exhibited an organic vapor reading. The second drum contained approximately 10 gallons of a bright green liquid that did not exhibit an organic vapor reading. The third drum contained approximately 15 to 20 gallons of an oily substance that did not exhibit an organic vapor reading. The grey liquid sample exhibited mononuclear (toluene, ethylbenzene, total xylenes) and polynuclear (naphthalene, 2-methylnaphthalene, phenanthrene) aromatic hydrocarbons; several metals (aluminum, arsenic, barium, cadmium, chromium, iron, lead, manganese, mercury, zinc); and cyanide. The other two liquid samples exhibited primarily metals. These analytical data are presented in Attachment F to the TAT memorandum (Ref. 12).

Two sediment samples were also collected for chemical analyses from the bed of an intermittent stream located south (down gradient) of the soil embankment. A sample of a white powdery substance found within the excavated debris was also sampled

(Ref. 12). Metals were detected in the sediment samples; however, iron appears to be the only metal detected above typical background concentrations for soil (Ref. 14, pp. 4, 6). The sample of the white powdery substance exhibited numerous metals and cyanide (Ref. 12), potentially characteristic of paint waste.

During the past investigation of the A.L. Taylor site, approximately 140 individual chemical compounds have been identified. The chemicals found most often and in highest concentration include total xylenes, phthalate, toluene, alkylbenzenes, methyl ethyl ketone, methylene chloride, acetone, anthracene, vinyl chloride, trans-1,2-dichloroethylene, fluoranthene, and several long-chain aliphatic acids. Selected heavy metals were also detected in soils, surface water runoff, and groundwater samples collected at the A.L. Taylor site (Ref. 15, p. 2-8).

3.0 Groundwater Pathway

3.1 Hydrogeologic Setting

The site is located within the Interior Low Plains physiographic subdivision of the Interior Plain. The site lies along the edge of the Knobs Region, a range of isolated round hills and maturely dissected upland, and the rolling hills of the Outer Blue Grass Region to the east. The Knobs Region is characterized by erosional remnants formed from Mississippian rocks overlying Silurian and Devonian rocks. Mississippian rocks are limestones and siltstones with some shale beds; Pennsylvanian rocks are sandy limestones and sandstones (Refs. 8, pp. 3-3 through 3-5; 16, p. 15).

Surface relief near the site is approximately 110 feet, with elevations ranging from 650 to 540 feet above mean sea level (AMSL) (Refs. 1; 9, p. 6). Sloping hills to the northwest of the site are concave in shape and are steeper near the summit. This topography is the result of rock types more resistant to erosion (i.e., siltstone formations) occurring near the ridge tops (Refs. 9, p. 6; 17). Much of the precipitation in this region leaves the ground surface rapidly as overland runoff to local streams. Only a small amount of water seeps below the soil mantle to deeper water-bearing formations (Ref. 18, p. C5-C8).

Moving from higher elevation to lower, the soils near the site include four primary soil series: the Zanesville silt loam, the Captina silt loam, the Otwell silt loam, and the Newark silt loam. Soils from each series are present in various phases that vary by slope. The Zanesville silt loam, present at 2 to 6 percent slopes, 6 to 12 percent slopes, and 12 to 20 percent slopes near the site, are characterized by moderately well-drained or well-drained loess soils near the surface and upper subsoil strata, and residuum derived from shale in the lower subsoil stratum. The lower portion is a compact fragipan that restricts the movement of water. Erosion of this soil ranges from a moderately-low to a moderately-severe problem (Ref. 19, pp. 38-39). The Capitina silt loam, 2 to 6 percent slopes, consist of moderately well-drained gently sloping soils formed in old alluvium derived from soils of limestone origin. Erosion hazard is slight (Ref. 19, p. 12). The Otwell silt loam, present at 2 to 6 percent slopes and 6 to 12 percent slopes near the site, are characterized by deep, moderately well-drained soil formed on stream terraces. Permeability is very slow (Ref. 20). Within the Otwell soil are areas of Newark silt loam that occur along the Wilson Creek flood plain. The Newark soil is a deep somewhat poorly-drained bottoms soil formed in recent alluvium that is principally of limestone origin. The Otwell and Newark soils may be subject to occasional flooding.

The subsurface stratigraphy near the site is composed of the following geologic units (in descending order) (Ref. 8, pp. 3-5):

- One to 14 feet of silty clay overburden underlain by 1 to 11 feet of weathered shale.
- Approximately 60 to 90 feet of lower Mississippian-age shale with limestone patches and lenses; fine-grained sandstone layers with interbedded shale are present at the top of this unit (New Providence Shale).
- Approximately 60 to 90 feet of Upper Devonian-age massive shale containing thin sandstone and shale layers (New Albany Shale).
- Approximately 90 to 130 feet of Middle Silurian-age thick-bedded, fine-grained limestone (Louisville Limestone).
- An unknown thickness of Middle Silurian-age shale that acts as basal confining layer of the Louisville Limestone (Waldron Shale).

Infiltration most likely occurs from recharge areas in adjacent higher terrain north and west of the site. Groundwater is present near the site in a shallow unconfined perched aquifer that generally provides insufficient yield for drinking water supplies (Ref. 10, p. 3). Groundwater moves slowly to the east and south (toward Wilson Creek) through the overburden at or near the top of the unweathered shale and through fractures and joints in the weathered shale. While the overburden, New Providence Shale, New Albany Shale, and Louisville Limestone yield a minimal amount of groundwater, the Waldron Shale yields almost no groundwater to wells or springs (Ref. 8, p. 3-5).

Based upon soil permeability testing, groundwater movement is estimated to be less than 0.15 feet per year near the site (Refs. 8, p. 3-4; 21, pp. 25-26). Although the shale is fractured 30 to 35 feet below ground surface, it is insignificant with regard to groundwater flow. Groundwater from the shale is of sufficient quality for potable water supplies but of insignificant yield. Groundwater from the limestone is brackish with yields less than five gallons per minute (Ref. 8, pp. 3-4 through 3-6).

3.2 Groundwater Targets

The majority of the residents within a 4-mile radius (target distance limit) of the site receive potable water supplied by the Louisville Water Company (Refs. 1; 22). This system draws water from surface water intakes on the Ohio River in northern Jefferson County. The nearest intake is located more than 20 miles upstream of the point at which surface water runoff from the site enters the Ohio River at the Salt River (Refs. 1; 22). Other water distribution systems in the region include the Salt River Water District (SRWD), the Kentucky Turnpike Water District (KTWD), the Shepardsville Water Company (SWC), and municipal systems for the city of West Point and Fort Knox Military Reservation. The SRWD, the KTWD, and the SWC purchase water from the Louisville Water Company (Refs. 23; 24; 25). No residents within a 4-mile radius of the site receive potable water from the West Point or Fort Knox systems (Refs. 26; 27). Residents in northwest Bullitt County that are not connected to the public water supply system receive potable water from private wells or cisterns (Ref. 28). Private wells in the Knob Hills regions of Jefferson and Bullitt Counties draw water from shallow water-bearing zones at screened depths between 60 to 100 feet below ground surface (Ref. 29).

A water usage summary for the population within the 4-mile site target area is shown in Table 1. These data were based on a house count and supplemental Graphical Exposure Modelling System (GEMS) data (Refs. 30; 31; 32). From the total estimated population of 31,558 persons, over 97.5 percent of the residents in the target area are estimated to be public water supply users.

The maximum groundwater migration rate is estimated to be 2.4 feet per year in the direction of Wilson Creek south of the site (Ref. 15, p. 2-24). The closest residential well is located 1,300 feet south of the site; however, this well is not used for drinking water due to poor yield. The screened interval of this private well is unknown. The five homes south of the site on Letts Road currently obtain drinking water from private cisterns (Refs. 6; 15, p. 2-32). Several monitoring wells screened in the overburden materials, the New Providence and New Albany shales, and the Louisville limestone are located on and around the A.L. Taylor site. (Refs. 8; 9).

4.0 Surface Water Pathway

4.1 Hydrologic Setting

Surface water runoff from the source area of the site occurs as overland flow that is received by a tributary to Wilson Creek. Wilson Creek is an intermittent stream approximately 400 feet southeast of the site (Ref. 1). From the point of runoff interception, Wilson Creek flows toward the northwest as an intermittent stream. This segment of Wilson Creek is a drainage swale paralleling the L&N railroad.

The surface water migration pathway begins approximately 1-¼ miles northwest of the site near Coral Ridge. At the probable point of entry (PPE), Wilson Creek receives flow from tributaries that drain the upland forest and the residential valley of South Park Hills and stream flow becomes perennial. Approximately 1-½ miles downstream, Wilson Creek receives flow from Little Bee Lick Creek northeast of the city of Fairdale. Approximately 1-⅛ miles to the northwest, Wilson Creek empties into South Ditch at South Park. Approximately ½ mile down stream, South Ditch receives flow from North Ditch near a sewage discharge. South Ditch empties into Pond Creek approximately 2 miles to the southwest (Ref. 1).

Table 1
Water Usage Within 4-Mile Target Distance of
Jefferson Forest Drum Site

Distance from Site	Public Supply(a)			Private Supply(b)			Potential GW Targets
	Houses	Persons per House	Population Estimate	Houses	Persons per House	Population Estimate	
0 - ¼ mile	0 0	2.48(c) 2.97(d)	0	1 3	2.48(c) 2.97(d)	2 9	11
¼ - ½ mile	0 13	2.48(c) 2.97(d)	38	0 6	2.48(c) 2.97(d)	0 18	18
½ - 1 mile	124 95	2.48(c) 2.97(d)	589	20 5	2.48(c) 2.97(d)	50 15	65
1 - 2 miles	979 548	2.48(c) 2.97(d)	4,056	30 47	2.48(c) 2.97(d)	74 140	214
2 - 3 miles	n.a.	n.a.	19,271	31 27	2.48(c) 2.97(d)	77 80	157
3 - 4 miles	n.a.	n.a.	6,828	39 72	2.48(c) 2.97(d)	97 214	311
Total Public Water Supply Users			30,782	Total Private Water Supply Users			776

(a) All public water supplies in the target area are part of the Louisville Water Co. distribution system (Refs. 22; 23; 24; 25).

(b) Determined by a house count in areas outlying the public water supply distribution system; private supplies include wells and cisterns (Ref. 1).

(c) Jefferson County, 2.48 persons/house (Ref. 31, p. 7).

(d) Bullitt County, 2.97 persons/house (Ref. 31, p. 6).

n.a. not applicable

Pond Creek begins approximately ¼ mile southwest of the U.S. Geological Survey (USGS) flow gauging station 03302000 located at the Manslick Road bridge (Ref. 33, p. 156). Approximately 9-½ miles southwest (downstream) from its origin, Pond Creek receives flow from Brier Creek. Brier Creek drains the forested Knobs of the Jefferson Memorial Forest between Miller, Samuel, and Pendleton hills. At this point, Pond Creek forms the border between Jefferson and Bullitt counties. The surface water target distance limit from the site ends approximately 1 mile to the southwest in the alluvial floodplain near Kosmosdale. Pond Creek continues to flow southwest for approximately 4-½ miles to its confluence with the Salt River. The Salt River flows northwest ½ mile to its confluence with the Ohio River near river mile marker 630 (Ref. 1).

The site is not located within a recognized flood hazard area (Ref. 34). No historic flow gauging data are available for Wilson Creek; however, the flow rate is estimated to be 0.1 cubic foot per second. The stream flow is subject to fluctuation based upon seasonal rainfall and snowmelt (Ref. 15, pp. 2-24 and 2-25). The average annual flow rate in Pond Creek at USGS flow gauging station 03302000 is approximately 90 cubic feet per second (cfs). The drainage area for the Pond Creek basin is 64 square miles at this gauging station (Ref. 33, p. 156).

4.2 Surface Water Targets

There are no drinking water or major commercial intakes located along the 15-mile (target distance limit) surface water migration pathway (Refs. 15, pp. 2-31 through 2-35; 35).

Wilson and Pond Creeks were sampled in March 1979 under the direction of the Kentucky Division of Water Quality. As a result of this study, several aquatic species that are typically found in fresh water streams in Kentucky and that are somewhat intolerant of man-induced disturbances were observed (Ref. 8, p. 3-11). There are no documented observances of threatened or endangered aquatic species along the 15-mile surface water pathway (Ref. 36; 37). The rivers leading from Wilson Creek within the surface water pathway are not considered fisheries except as possible habitats for darters or minnows (Refs. 15, p. 2-34; 38). Recreational fishing is known

to occur in Pond Creek (Ref. 38). Limited information is available regarding other recreational surface water usage along the 15-mile pathway.

There were no observed wetlands on the site (Ref. 6). However, wetlands are located along portions of Wilson Creek, Southern Ditch, and Pond Creek within the 15-mile surface water pathway (Ref. 39). The in-flow frontage along Wilson Creek is composed of ⅞-mile of Palustrine, deciduous, temporarily flooded wetland and 200 feet of Palustrine, emergent, seasonally flooded wetland. The in-flow frontage along Southern Ditch is composed of 1-⅓ mile of man-modified, unclassified wetland and ⅜-mile of Palustrine, deciduous, temporarily and seasonally flooded wetland. The in-flow frontage along Pond Creek is composed of 1-¼ mile of Palustrine, deciduous, emergent and temporarily flooded wetland (Ref 40).

5.0 Soil Exposure and Air Pathways

5.1 Physical Conditions

Although pedestrian access to the site is unrestricted, the site lies within an undeveloped heavily-wooded area of the Jefferson Memorial Forest and is accessible only by unmaintained trails. Vehicular access is difficult due to the rugged terrain and brush and tree growth (Ref. 6). However, it has been reported that the barren soil area immediately east of the site has been used for recreational off-road vehicle traffic (e.g., motorcycles, all-terrain trucks) (Ref. 7). The area surrounding the site is sparsely populated. However, nearby residents periodically travel the unmaintained trail at the top of the waste disposal soil embankment (Ref. 6). The soil embankment was observed to be overgrown with brush and is not easily accessible by foot. No distressed vegetation was observed at or downgradient from the site (Ref. 6).

5.2 Soil and Air Targets

Although waste materials were previously disposed of in the area of the soil embankment, no current disposal operations are practiced at the site (Ref. 6). There are no schools, residences, or daycare facilities within 200 feet of the source area. The nearest residence, owned by [redacted] is located approximately 1,200 feet south of the source area (Refs. 1; 6; 7). A privately-owned golf course is located 1,600 feet southeast of the site, and a trailer park is located approximately 4,200 feet

southeast of the site. The nearest industry, a clay quarrying and brick kiln facility, is located 1,600 feet north of the site. The nearest school, Coral Ridge Elementary School, is located approximately 1-¼ miles northwest of the site (Ref. 1).

There are no known occurrences of threatened or endangered species present on the site (Ref. 37). Documented observances of endangered plant species have included: the Carolina fanwort (*Cabomba caroliniana*) and the Wharton's dewberry (*Rubus whartoniae*), observed ½ mile north of the site; the Grassleaf arrowhead (*Sagitaria graminea var. graminea*), observed ¾-mile north of the site; and the Blackfoot quillwort (*Isoetes melanopoda*), observed 3-½ miles northwest of the site (Ref. 36; 37). The estimated population within a 4-mile radius of the site is approximately 31,558 persons and is detailed as follows: onsite, 0 persons; 0 to ¼ mile, 11 persons; ¼ to ½ mile, 56 persons; ½ to 1 mile, 654 persons; 1 to 2 miles, 4,270 persons; 2 to 3 miles, 19,428 persons; 3 to 4 miles, 7,139 persons (Ref. 31).

6.0 Summary and Conclusions

The site is located near the intersection of Brooks and Letts roads in a heavily wooded area of the Jefferson Memorial Forest. It is characterized by a soil embankment approximately 200 feet in length. The soil embankment parallels a trail leading from an LG&E maintenance road north of the A.L. Taylor Superfund site. The A. L. Taylor site was formerly used for disposal activities, the duration and nature of which are unknown. The soil embankment is the only suspected source area at the site.

Following information provided by a nearby resident, the site was discovered by KDEP personnel on November 13, 1992. The KDEP investigators noted 44 fully- and partially-exposed drums, household appliances, and scrap metal present within the soil embankment. Under the TAT contract, exploratory excavation was performed at the site on February 10, 1993, to delineate the extent of past disposal activities. Fill material was noted to be shallow within the soil embankment. Twenty to 25 empty drums were removed, crushed, and stockpiled. Three drums, each containing 7 to 20 gallons of liquid, were found. Waste is suspected to have been released from these drums.

During a site reconnaissance conducted on September 14, 1993, materials noted at the base of the soil embankment within the fill material include corroded drum carcasses and metal containers, insulation material, building debris, glass vials, scrap metal and appliances, sealant, and powdery and solidified dry solids. This site may have been owned by A.L. Taylor and used for municipal and industrial waste disposal operations. However, environmental sampling of drummed liquids, dry surficial solids, and downgradient sediments during the TAT removal action did not reveal notable contamination.

The majority of residents within the 4-mile target area receive drinking water from municipal supplies. Residents within rural Bullitt and Jefferson counties not connected to these supplies receive potable water from private wells or cisterns screened at depths from 60 to 100 feet below ground surface. Residents south of the site on Letts Road receive water from private cisterns. The closest active drinking water well is more than ½ mile from the site. The maximum groundwater migration rate near the site is estimated to be less than 2.4 feet per year.

Surface water runoff from the site is received by a tributary to Wilson Creek. Wilson Creek flows as an intermittent stream for 1-¼ miles to the PPE for the surface water migration route. The surface water route includes Wilson Creek, Southern Ditch, and Pond Creek within the 15-mile target distance limit. There are no drinking water or major commercial intakes along the surface water route. Wilson and Pond Creeks may be used as possible habitats for darters and minnows; Pond Creek is used for recreational fishing. Wetlands are located along portions of Wilson Creek, Southern Ditch, and Pond Creek. While a release to the ground surface at the site is suspected, measurable contamination along the surface water migration route from the site is not likely.

Although access to the site is unrestricted, it lies within an undeveloped area. However, nearby residents periodically use the trails near the site. The soil embankment supports a good vegetative stand; however, the wastes material is poorly contained. There are no schools, residences, or daycare facilities within 200 feet of the site. The nearest residence is located 1,200 feet to the south of the source area. There are no known occurrences of threatened or endangered species on the site.

7.0 References

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CONFIDENTIAL
Hazard Ranking System Preliminary Score

For

Jefferson Forest Drum Site
Jefferson Memorial Forest, Jefferson County, Kentucky

This preliminary score was calculated using the PAScore computer program. The pathways evaluated included ground water, surface water, soil, and air. Specific contaminants of concern could not be determined from the site background information (which has included environmental sampling). However, suspected contaminants include volatile and semivolatile organic compounds associated with solvents, sealants, and paint wastes; petroleum hydrocarbons associated with lubrication oils; and metals and inorganics associated with paint pigments. Material disposed at the site includes drum carcasses, metal containers, scrap metal, construction debris, dry solids, insulation, and glass vials.

A hazardous waste characteristics score of 18 was calculated based upon the estimated volume of the soil embankment (landfill), and drums and non-drum containers noted at the site. These wastes compose the only suspected source area at the site.

The ground water pathway scored low due to the absence of primary targets. Ground water migration near the site is slow and the shallow perched and confined aquifers present in the area are not used as drinking water resources near the site.

The surface water pathway scored low, but is slightly impacted due to the presence of nearby secondary human food chain targets. Wilson Creek, a low flow stream, Southern Ditch, a minimal flow stream, and Pond Creek, a minimal flow stream, are potential recreational fisheries located within the surface water target area.

The soil exposure pathway scored low due to the absence of targets near the suspected source area at the site.

The air pathway scored low due to the sparse population (no targets) near the site and the low number of sensitive environments in the target area.

No further investigation of the site is recommended based upon the absence of identified primary targets, low pathway scores, and resulting overall low site score.

S_{gw}	=	4
S_{sw}	=	16
S_{se}	=	2
S_{a}	=	4
Overall Score	=	9

OMB Approval Number: 2050-0095
Approved for Use Through: 4/95

Site Name: Jefferson Forest Drum Site
CERCLIS ID No.: KYD985112986
Street Address: Near Inter. Brooks & Letts Rds.
City/State/Zip: Jefferson Memorial Forest, KY 40109

Investigator: John P. Nett
Agency/Organization: BVWST
Street Address: 1117 Perimeter Center West, W-212
City/State: Atlanta 30338, GA

Date: 10/27/93

WASTE CHARACTERISTICS

Waste Characteristics (WC) Calculations:

1 Soil Embankment	Landfill	Ref: 6,7	WQ value	maximum
Volume	3.00E+04 cu ft		4.44E-01	4.44E-01

Based upon the documentation of KDEP personnel and observations made during the site reconnaissance, a fill area exhibiting waste material (e.g., drum carcasses, metal containers, construction debris, laboratory vials, insulation, dry solids, scrap metal) is present at the site. The approximate dimensions of this disposal area are 300' x 25' x 4'.
Ref: 6,7

2 Contained Wastes	Drums	Ref: 6,7	WQ value	maximum
Volume	4.40E+01 drums		4.40E+00	4.40E+00

KDEP personnel observed 44 partially- and fully-exposed drums within the soil embankment. These drums were noted to be severly corroded. One drum was observed to be leaking, while another contained liquid but was not leaking.
Ref: 7

3 Uncontained Wastes	Non-drum containers	Ref: 6,7	WQ value	maximum
Volume	1.00E+01 gals		2.00E-02	2.00E-02

KDEP personnel observed several hundred tubes of water-proof sealant on the ground surface.

Waste volume = 10 gallons (200 tubes x 8 ounces per tube x 1/16 pound per ounce x 1/10 gallon per pound)
Ref: 7

WQ total 4.86E+00

** Only First WC Page Is Printed ** | Waste Characteristics Score: WC = 18

Ground Water Pathway Criteria List
Suspected Release

Are sources poorly contained? (y/n/u)	Y
Is the source a type likely to contribute to ground water contamination (e.g., wet lagoon)? (y/n/u)	Y
Is waste quantity particularly large? (y/n/u)	N
Is precipitation heavy? (y/n/u)	Y
Is the infiltration rate high? (y/n/u)	N
Is the site located in an area of karst terrain? (y/n)	N
Is the subsurface highly permeable or conductive? (y/n/u)	N
Is drinking water drawn from a shallow aquifer? (y/n/u)	N
Are suspected contaminants highly mobile in ground water? (y/n/u)	Y
Does analytical or circumstantial evidence suggest ground water contamination? (y/n/u)	N

Other criteria? (y/n) N

SUSPECTED RELEASE? (y/n) N

Summarize the rationale for Suspected Release:

The source areas are confined to a single soil embankment. No visible leachate was observed to be flowing from the soil embankment. Precipitation from the site leaves rapidly as runoff and only a minimal amount seeps below the soil mantle to underlying water-bearing units. The ground water migration rate near the site is estimated to be no greater than 2.4 feet per year.

Ref: 6,7,8,15,18,21

Ground Water Pathway Criteria List
Primary Targets

Is any drinking water well nearby? (y/n/u)

Has any nearby drinking water well been closed? (y/n/u)

Has any nearby drinking water well user reported foul-testing or foul-smelling water? (y/n/u)

Does any nearby well have a large drawdown/high production rate? (y/n/u)

Is any drinking water well located between the site and other wells that are suspected to be exposed to a hazardous substance? (y/n/u)

Does analytical or circumstantial evidence suggest contamination at a drinking water well? (y/n/u)

Does any drinking water well warrant sampling? (y/n/u)

Other criteria? (y/n)

PRIMARY TARGET(S) IDENTIFIED? (y/n)

Summarize the rationale for Primary Targets:

GROUND WATER PATHWAY SCORESHEETS

Pathway Characteristics		Ref.
Do you suspect a release? (y/n)	No	
Is the site located in karst terrain? (y/n)	No	
Depth to aquifer (feet):	60	29
Distance to the nearest drinking water well (feet):	3400	1

LIKELIHOOD OF RELEASE	Suspected Release	No Suspected Release	References
1. SUSPECTED RELEASE	0		
2. NO SUSPECTED RELEASE		500	
LR =	0	500	

Targets

TARGETS	Suspected Release	No Suspected Release	References
3. PRIMARY TARGET POPULATION 0 person(s)	0		
4. SECONDARY TARGET POPULATION Are any wells part of a blended system? (y/n) N	0	14	
5. NEAREST WELL	0	20	
6. WELLHEAD PROTECTION AREA None within 4 Miles	0	0	
7. RESOURCES	0	5	
T =	0	39	

WASTE CHARACTERISTICS		
WC =	0	18

GROUND WATER PATHWAY SCORE: 4

Ground Water Target Populations

Primary Target Population Drinking Water Well ID	Dist. (miles)	Population Served	Reference	Value
None				
*** Note : Maximum of 5 Wells Are Printed ***			Total	

Secondary Target Population Distance Categories	Population Served	Reference	Value
0 to 1/4 mile	11	1,28	2
Greater than 1/4 to 1/2 mile	18	1,28	1
Greater than 1/2 to 1 mile	65	1,28	2
Greater than 1 to 2 miles	214	1,28	3
Greater than 2 to 3 miles	157	1,28	2
Greater than 3 to 4 miles	311	1,28	4
		Total	14

Apportionment Documentation for a Blended System

All municipal supplies within the 4-mile target area receive water from the Louisville Water Company (LWC). The LWC system draws water from the Ohio River and does not pump ground water.

Ref: 22

Surface Water Pathway Criteria List
Suspected Release

Is surface water nearby? (y/n/u)	N
Is waste quantity particularly large? (y/n/u)	N
Is the drainage area large? (y/n/u)	Y
Is rainfall heavy? (y/n/u)	Y
Is the infiltration rate low? (y/n/u)	Y
Are sources poorly contained or prone to runoff or flooding? (y/n/u)	Y
Is a runoff route well defined(e.g.ditch/channel to surf.water)? (y/n/u)	Y
Is vegetation stressed along the probable runoff path? (y/n/u)	N
Are sediments or water unnaturally discolored? (y/n/u)	N
Is wildlife unnaturally absent? (y/n/u)	N
Has deposition of waste into surface water been observed? (y/n/u)	N
Is ground water discharge to surface water likely? (y/n/u)	N
Does analytical/circumstantial evidence suggest S.W. contam? (y/n/u)	N

Other criteria? (y/n) N

SUSPECTED RELEASE? (y/n) N

Summarize the rationale for Suspected Release:

The overland flow route from the site to the PPE is 1-1/4 miles occuring as a perennial stream. While rainfall is heavy and the majority of precipitation will become runoff, releases to the natural drainage channel down gradient of the site would be minimal based upon the previously observed conditions. Sediment samples collected down gradient of the soil embankment did not reveal elevated contaminant levels.

Ref: 1,6,7,12

Surface Water Pathway Criteria List
Primary Targets

Is any target nearby? (y/n/u) If yes: N
- N Drinking water intake
- N Fishery
- N Sensitive environment

Has any intake, fishery, or recreational area been closed? (y/n/u) N

Does analytical or circumstantial evidence suggest surface water contamination at or downstream of a target? (y/n/u) N

Does any target warrant sampling? (y/n/u) If yes: N
- N Drinking water intake
- N Fishery
- N Sensitive environment

Other criteria? (y/n) N

PRIMARY INTAKE(S) IDENTIFIED? (y/n) N

Summarize the rationale for Primary Intakes:

There are no drinking water intakes along the 15-mile in-water segement of the surface water migration route.

Ref: 22,23,24,25,26,27,28
continued -------

continued -------

Other criteria? (y/n) N

PRIMARY FISHERY(IES) IDENTIFIED? (y/n) N

Summarize the rationale for Primary Fisheries:

Past sediment sampling of the drainage channel down gradient from source areas at the site did not reveal elevated contaminant levels. This drainage channel intercepts Wilson Creek. Wilson Creek flows as an intermittent stream for a distance of 1-1/4 miles to the PPE. These factors tend to limit the potential transport of contaminants to surface water.

Ref: 1,12

Other criteria? (y/n) N

PRIMARY SENSITIVE ENVIRONMENT(S) IDENTIFIED? (y/n) N

Summarize the rationale for Primary Sensitive Environments:

Same rationale as that provided for the surface-water-pathway, human-food-chain threats criteria list rationale for primary fisheries.

SURFACE WATER PATHWAY SCORESHEETS

Pathway Characteristics		Ref.
Do you suspect a release? (y/n)	No	
Distance to surface water (feet):	6600	1
Flood frequency (years):	500	34
What is the downstream distance (miles) to:		
a. the nearest drinking water intake?	N.A.	22
b. the nearest fishery?	1.2	15,38
c. the nearest sensitive environment?	2.2	39

LIKELIHOOD OF RELEASE	Suspected Release	No Suspected Release	References
1. SUSPECTED RELEASE	0		
2. NO SUSPECTED RELEASE		300	
LR =	0	300	

Drinking Water Threat Targets

TARGETS	Suspected Release	No Suspected Release	References
3. Determine the water body type, flow (if applicable), and number of people served by each drinking water intake.			
4. PRIMARY TARGET POPULATION 0 person(s)	0		
5. SECONDARY TARGET POPULATION Are any intakes part of a blended system? (y/n): N	0	0	
6. NEAREST INTAKE	0	0	
7. RESOURCES	0	5	
T =	0	5	

Drinking Water Threat Target Populations

Intake Name	Primary (y/n)	Water Body Type/Flow	Population Served	Ref.	Value
None					

Total Primary Target Population Value	0
Total Secondary Target Population Value	0

*** Note : Maximum of 6 Intakes Are Printed ***

Apportionment Documentation for a Blended System

Human Food Chain Threat Targets

TARGETS	Suspected Release	No Suspected Release	References
8. Determine the water body type and flow for each fishery within the target limit.			
9. PRIMARY FISHERIES	0		
10. SECONDARY FISHERIES	0	210	
T =	0	210	

Human Food Chain Threat Targets

Fishery Name	Primary (y/n)	Water Body Type/Flow	Ref.	Value
1 Wilson Creek	N	<10 cfs	15	210
2 Pond Creek	N	10-100 cfs	33	30

Total Primary Fisheries Value	0
Total Secondary Fisheries Value	0

*** Note : Maximum of 6 Fisheries Are Printed ***

Environmental Threat Targets

TARGETS	Suspected Release	No Suspected Release	References
11. Determine the water body type and flow (if applicable) for each sensitive environment.			
12. PRIMARY SENSITIVE ENVIRONMENTS	0		
13. SECONDARY SENSITIVE ENVIRONS.	0	35	
T =	0	35	

Environmental Threat Targets

Sensitive Environment Name	Primary (y/n)	Water Body Type/Flow	Ref.	Value
1 Wilson Creek	N	<10 cfs	39	25
2 Southern Ditch	N	10-100 cfs	39	5
3 Pond Creek	N	10-100 cfs	39	5

Total Primary Sensitive Environments Value 0
Total Secondary Sensitive Environments Value 0

*** Note: Maximum of 6 Sensitive Environments Are Printed ***

Surface Water Pathway Threat Scores

Threat	Likelihood of Release(LR) Score	Targets(T) Score	Pathway Waste Characteristics (WC) Score	Threat Score LR x T x WC / 82,500
Drinking Water	300	5	18	0
Human Food Chain	300	210	18	14
Environmental	300	35	18	2

SURFACE WATER PATHWAY SCORE: 16

Soil Exposure Pathway Criteria List
Resident Population

Is any residence, school, or daycare facility on or within 200 feet of an area of suspected contamination? (y/n/u)	N
Is any residence, school, or daycare facility located on adjacent land previously owned or leased by the site owner/operator? (y/n/u)	U
Is there a migration route that might spread hazardous substances near residences, schools, or daycare facilities? (y/n/u)	N
Have onsite or adjacent residents or students reported adverse health effects, exclusive of apparent drinking water or air contamination problems? (y/n/u)	N
Does any neighboring property warrant sampling? (y/n/u)	N

Other criteria? (y/n) N

RESIDENT POPULATION IDENTIFIED? (y/n) N

Summarize the rationale for Resident Population:

There are no targets located within 200 feet of areas of suspected contamination.

Ref: 1,6,7

SOIL EXPOSURE PATHWAY SCORESHEETS

Pathway Characteristics		Ref.
Do any people live on or within 200 ft of areas of suspected contamination? (y/n)	No	1,6,7
Do any people attend school or daycare on or within 200 ft of areas of suspected contamination? (y/n)	No	1,6,7
Is the facility active? (y/n):	No	1,6,7

LIKELIHOOD OF EXPOSURE	Suspected Contamination	References
1. SUSPECTED CONTAMINATION LE =	550	

Targets

2. RESIDENT POPULATION 0 resident(s) 0 school/daycare student(s)	0	 1,6,7 1,6,7
3. RESIDENT INDIVIDUAL	0	
4. WORKERS None	0	1,6,7
5. TERRES. SENSITIVE ENVIRONMENTS	0	
6. RESOURCES	5	
T =	5	

WASTE CHARACTERISTICS

WC = 18

RESIDENT POPULATION THREAT SCORE: 1

NEARBY POPULATION THREAT SCORE: 1

Population Within 1 Mile: 1 - 10,000

SOIL EXPOSURE PATHWAY SCORE: 2

Soil Exposure Pathway Terrestrial Sensitive Environments

Terrestrial Sensitive Environment Name	Reference	Value
None		
Total Terrestrial Sensitive Environments Value		

*** Note : Maximum of 7 Sensitive Environments Are Printed ***

Air Pathway Criteria List
Suspected Release

Are odors currently reported? (y/n/u)	N
Has release of a hazardous substance to the air been directly observed? (y/n/u)	N
Are there reports of adverse health effects (e.g., headaches, nausea, dizziness) potentially resulting from migration of hazardous substances through the air? (y/n/u)	N
Does analytical/circumstantial evidence suggest release to air? (y/n/u)	N

Other criteria? (y/n) N

SUSPECTED RELEASE? (y/n) N

Summarize the rationale for Suspected Release:

Although the waste material is poorly contained and wind-blown dust may be associated with the soil embankment, the area immediately surrounding the site (within 1/4 mile) is heavily wooded and sparsely populated. No organic vapors were noted during past field screening of the soil embankment, however, drummed liquid wastes exhibited low levels of organic vapors. The area is well vegetated, reducing soil erosion.

Ref: 6,7

AIR PATHWAY SCORESHEETS

Pathway Characteristics

		Ref.
Do you suspect a release? (y/n)	No	
Distance to the nearest individual (feet):	1200	1,6,7

LIKELIHOOD OF RELEASE	Suspected Release	No Suspected Release	References
1. SUSPECTED RELEASE	0		
2. NO SUSPECTED RELEASE		500	
LR =	0	500	

Targets

TARGETS	Suspected Release	No Suspected Release	References
3. PRIMARY TARGET POPULATION 0 person(s)	0		
4. SECONDARY TARGET POPULATION	0	11	
5. NEAREST INDIVIDUAL	0	20	
6. PRIMARY SENSITIVE ENVIRONS.	0		
7. SECONDARY SENSITIVE ENVIRONS.	0	0	
8. RESOURCES	0	5	
T =	0	36	

WASTE CHARACTERISTICS

WC =	0	18

AIR PATHWAY SCORE: 4

Air Pathway Secondary Target Populations

Distance Categories	Population	References	Value
Onsite	0	31	0
Greater than 0 to 1/4 mile	11	31	1
Greater than 1/4 to 1/2 mile	56	31	1
Greater than 1/2 to 1 mile	654	31	1
Greater than 1 to 2 miles	4270	31	3
Greater than 2 to 3 miles	19428	31	4
Greater than 3 to 4 miles	7139	31	1
	Total Secondary Population Value		11

Air Pathway Primary Sensitive Environments

Sensitive Environment Name	Reference	Value
None		
Total Primary Sensitive Environments Value		

*** Note : Maximum of 7 Sensitive Environments Are Printed***

Air Pathway Secondary Sensitive Environments

Sensitive Environment Name	Distance	Reference	Value
1 Wharton's dewberry occurence	>1/4-1/2	36,37	0.3
Total Secondary Sensitive Environments Value			0

SITE SCORE CALCULATION	SCORE
GROUND WATER PATHWAY SCORE:	4
SURFACE WATER PATHWAY SCORE:	16
SOIL EXPOSURE PATHWAY SCORE:	2
AIR PATHWAY SCORE:	4
SITE SCORE:	9

SUMMARY

1. Is there a high possibility of a threat to any nearby drinking water well(s) by migration of a hazardous substance in ground water? No

   If yes, identify the well(s).

   If yes, how many people are served by the threatened well(s)? 0

2. Is there a high possibility of a threat to any of the following by hazardous substance migration in surface water?
   - A. Drinking water intake No
   - B. Fishery No
   - C. Sensitive environment (wetland, critical habitat, others) No

   If yes, identity the target(s).

3. Is there a high possibility of an area of surficial contamination within 200 feet of any residence, school, or daycare facility? No

   If yes, identify the properties and estimate the associated population(s)

4. Are there public health concerns at this site that are not addressed by PA scoring considerations? No

   If yes, explain:

OVERSIZED

DOCUMENT

Reference 2

LATITUDE SHEET #2
LI USING ENGINEER'S SCALE (1/60)

SITE NAME: JEFFERSON FOREST DRUM CERCLIS #: KYD985112986

AKA: — SSID: —

ADDRESS: NEAR NATIONAL TURNPIKE AND LETTS ROAD

CITY: BROOKS STATE: KY ZIP CODE: 40109

SITE REFERENCE POINT: SOUTHWEST CORNER OF SITE BOUNDARY

USGS QUAD MAP NAME: BROOKS, KY TOWNSHIP: N/A N/S RANGE: N/A E/W

SCALE: (1:24,000) MAP DATE: 1981 PHOTOREVISED 1987 SECTION: N/A 1/4 N/A 1/4 N/A 1/4

MAP DATUM: (1927) 1983 (CIRCLE ONE) MERIDIAN: —

COORDINATES FROM LOWER RIGHT (SOUTHEAST) CORNER OF 7.5' MAP (attach photocopy):

LONGITUDE: 85° 37' 30" LATITUDE: 38° 00' 00"

COORDINATES FROM LOWER RIGHT (SOUTHEAST) CORNER OF 2.5' GRID CELL:

LONGITUDE: 85° 42' 30" LATITUDE: 38° 05' 00"

CALCULATIONS: LATITUDE (7.5' QUADRANGLE MAP)

A) NUMBER OF RULER GRADUATIONS FROM LATITUDE GRID LINE TO SITE REF POINT: 17

B) MULTIPLY (A) BY 0.3304 TO CONVERT TO SECONDS:

A x 0.3304 = 5.62"

C) EXPRESS IN MINUTES AND SECONDS (1'= 60"): 0' 5.6"

D) ADD TO STARTING LATITUDE: 38° 05' 00.__" + 0' 5.6 =

SITE LATITUDE: 38° 05' 5.6" N

CALCULATIONS: LONGITUDE (7.5' QUADRANGLE MAP)

A) NUMBER OF RULER GRADUATIONS FROM RIGHT LONGITUDE LINE TO SITE REF POINT: 16.7

B) MULTIPLY (A) BY 0.3304 TO CONVERT TO SECONDS:

A x 0.3304 = 55.18"

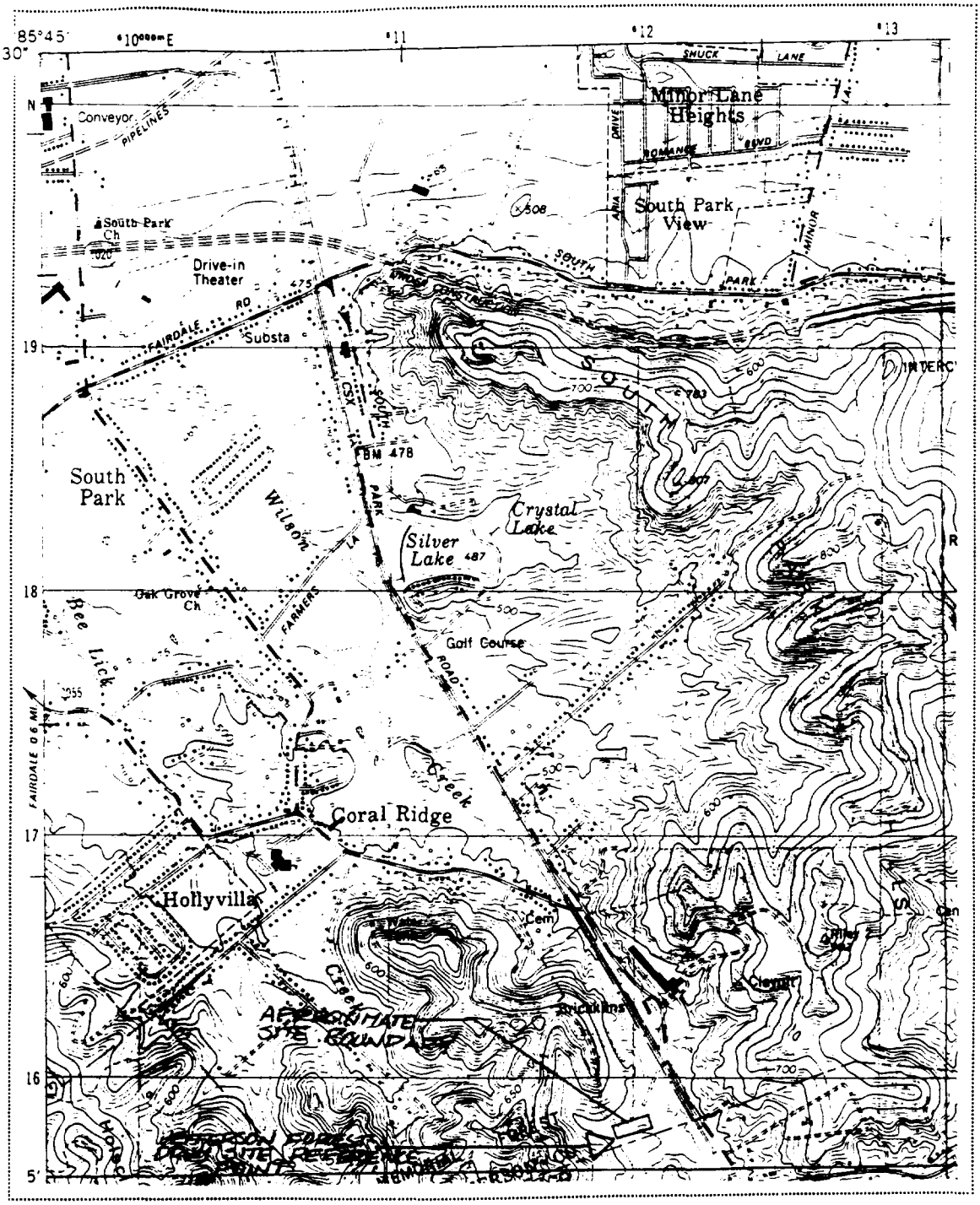
C) EXPRESS IN MINUTES AND SECONDS (1'= 60"): 0' 55.2"

D) ADD TO STARTING LONGITUDE: 85° 42' 30.__" + 0' 55.2 =

SITE LONGITUDE: 85° 43' 37.2" W

INVESTIGATOR: JOHN NETT DATE: 9/17/93

SITE NAME: JEFFERSON FOREST DRUM NUMBER: KYD985112986



TOPOGRAPHIC MAP QUADRANGLE NAME: BROOKS, KY SCALE: 1:24,000

COORDINATES OF LOWER RIGHT-HAND CORNER OF 2.5-MINUTE GRID:

LATITUDE: 38° 05' 00" LONGITUDE: 85° 42' 30"

*U.S. GOVERNMENT PRINTING OFFICE: 1991-548-187/40505

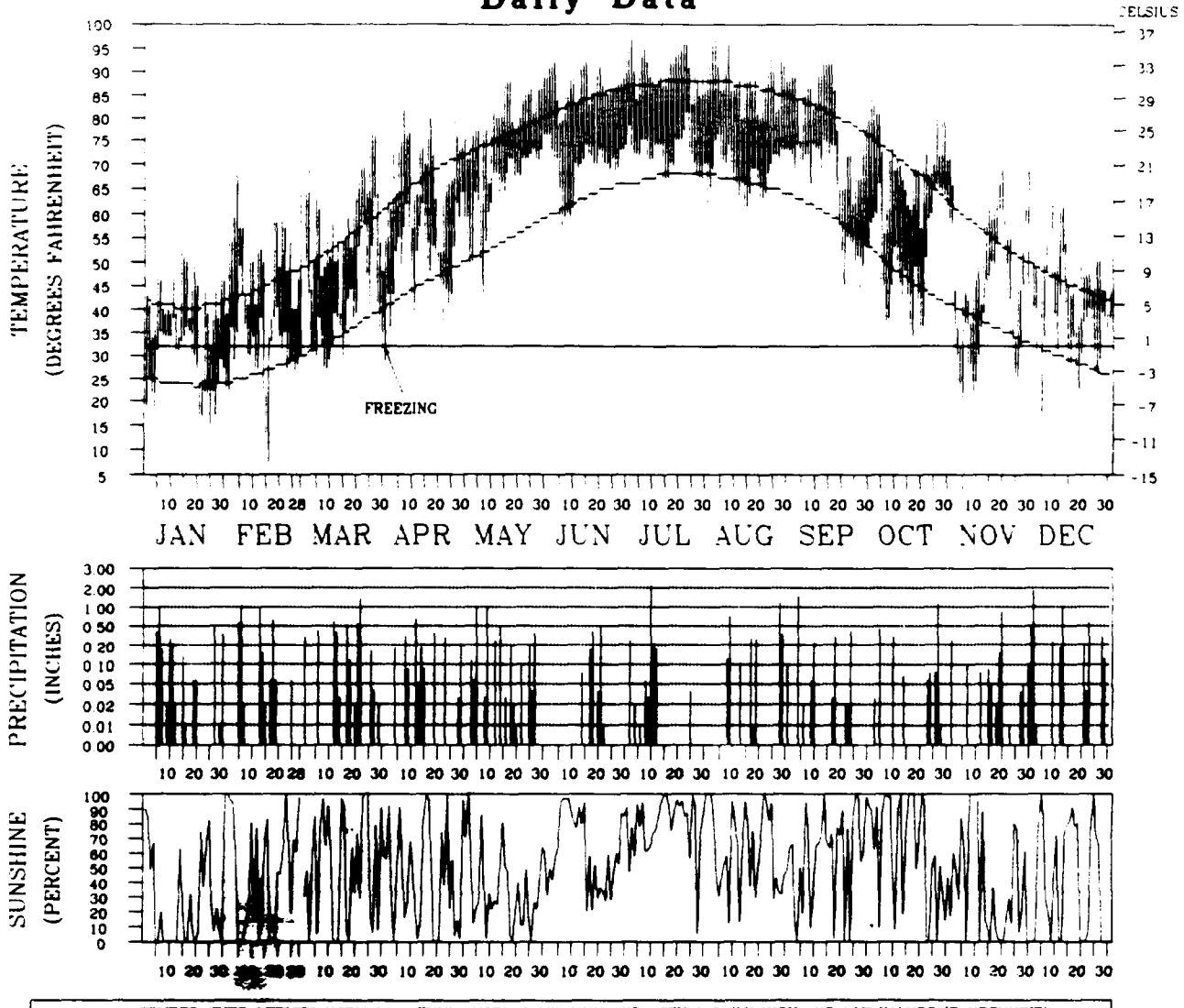
Reference 3

ISSN 0198-2257

1991 LOCAL CLIMATOLOGICAL DATA
ANNUAL SUMMARY WITH COMPARATIVE DATA

LOUISVILLE,
KENTUCKY

Daily Data



TEMPERATURE DEPICTS NORMAL MAXIMUM, NORMAL MINIMUM AND ACTUAL DAILY HIGH AND LOW VALUES (FAHRENHEIT)
PRECIPITATION IS MEASURED IN INCHES. SCALE IS NON-LINEAR
SUNSHINE IS PERCENT OF THE POSSIBLE SUNSHINE

I CERTIFY THAT THIS IS AN OFFICIAL PUBLICATION OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AND IS COMPILED FROM RECORDS ON FILE AT THE NATIONAL CLIMATIC DATA CENTER, ASHEVILLE, NORTH CAROLINA, 28801

Kenneth D. Hadeen
DIRECTOR,
NATIONAL CLIMATIC DATA CENTER

noaa
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL ENVIRONMENTAL SATELLITE, DATA AND INFORMATION SERVICE
NATIONAL CLIMATIC DATA CENTER ASHEVILLE NORTH CAROLINA

METEOROLOGICAL DATA FOR 1991

LOUISVILLE, KENTUCKY

LATITUDE [illegible] LONGITUDE [illegible] ELEVATION [illegible] BAROMETER [illegible] TIME ZONE EASTERN

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F													
Averages													
-Daily Maximum	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Daily Minimum	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Monthly	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Monthly Departure	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Extremes													
-Highest	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Date	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Lowest	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Date	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEGREE DAYS BASE 65 °F													
Heating	[illegible]	[illegible]	492	[illegible]	[illegible]	[illegible]	0	[illegible]	52	[illegible]	[illegible]	[illegible]	[illegible]
Cooling	[illegible]		8	31	296	406	514	445	262	68	[illegible]	[illegible]	2022
% OF POSSIBLE SUNSHINE	28	27	51	43	36	61	80	61	58	62	39	39	50
AVG. SKY COVER (tenths)													
Sunrise - Sunset	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Midnight - Midnight	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NUMBER OF DAYS:													
Sunrise to Sunset													
-Clear	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	36
-Partly Cloudy	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39
-Cloudy	[illegible]	[illegible]	15	18	[illegible]	[illegible]	8	[illegible]	[illegible]	14	20	[illegible]	180
Precipitation .01 inches or more	14	10	13	[illegible]	15	6	9	9	9	9	12	[illegible]	129
Snow, Ice pellets, hail 1.0 inches or more	0	0	0	0	0	0	0	0	0	0	0	0	0
Thunderstorms	0	0	5	5	6	8	5	10	4	2	0	0	45
Heavy Fog, visibility 1/4 mile or less	2	0	0	[illegible]	2	0	0	0	0	[illegible]	0	[illegible]	7
Temperature °F													
-Maximum													
90° and above	[illegible]	0	0	0	3	12	20	16	7	0	0	0	58
32° and below	3	[illegible]	0	0	0	0	0	0	0	0	[illegible]	0	6
-Minimum													
32° and below	21	16	[illegible]	0	0	0	0	0	0	0	13	15	76
0° and below	0	0	0	0	0	0	0	0	0	0	0	0	0
AVG. STATION PRESS. (mb)	1003.7	1001.5	994.6	998.3	999.3	998.6	998.0	999.7	1002.0	1000.7	1003.4	1004.7	1000.3
RELATIVE HUMIDITY (%)													
Hour 01	81	75	68	74	84	80	75	75	76	72	70	74	75
Hour 07 (Local Time)	84	80	76	77	88	82	79	83	84	84	73	80	81
Hour 13	73	60	54	54	64	53	49	51	52	50	60	64	57
Hour 19	77	64	60	56	68	58	53	54	59	60	63	67	62
PRECIPITATION (inches):													
Water Equivalent													
-Total	3.29	3.72	4.79	2.61	4.02	1.23	2.99	3.35	2.74	2.31	1.87	5.23	38.15
-Greatest (24 hrs)	1.05	1.40	2.03	0.69	1.08	0.54	1.19	1.24	1.57	1.18	0.88	1.90	2.19
-Date	6-7	5-6	21-22	12-13	4-5	20-21	9-10	28	4	27	20	2	JUL 9-10
Snow, Ice pellets, hail													
-Total	0.3	1.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	2.6
-Greatest (24 hrs)	0.2	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	0.6
-Date	12	25	29								24	3	FEB 25
WIND:													
Resultant													
-Direction (!!!)	290	256	235	201	183	157	254	110	239	199	233	251	226
-Speed (mph)	2.0	2.5	2.4	2.8	2.8	0.7	1.6	0.5	0.8	3.6	3.8	2.8	1.8
Average Speed (mph)	7.9	9.0	10.5	9.6	7.2	7.5	7.8	6.5	6.4	8.3	10.0	8.9	8.3
Fastest Obs. 1 Min.													
-Direction (!!!)	30	29	28	31	19	26	28	09	02	19	18	27	28
-Speed (mph)	22	28	33	31	25	22	29	23	17	23	26	28	33
-Date	21	14	28	23	25	21	2	28	20	26	30	3	MAR 28
Peak Gust													
-Direction (!!!)	W	W	NW	SW	N	W	W	E	N	S	SW	W	NW
-Speed (mph)	28	39	56	45	38	36	44	33	26	31	37	36	56
-Date	21	14	22	9	14	21	2	28	13	26	1	15	MAR 22

(!!!) See Reference Notes on Page 68

NORMALS, MEANS, AND EXTREMES

LOUISVILLE, KENTUCKY

[illegible]	[illegible]	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANN	[illegible]
TEMPERATURE °F:															
Normals															
-Daily Maximum		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Daily Minimum		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Mean		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Extremes															
-Record Highest	44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Year		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	JUL	[illegible]
-Record Lowest	44	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-Year		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	JAN	[illegible]
NORMAL DEGREE DAYS:															
Heating (base 65°F)		1008	915	624	264	88	5	0	0	32	250	567	962		4535
Cooling (base 65°F)		0	0	7	12	110	266	391	353	179	24	0	0		1342
% OF POSSIBLE SUNSHINE	44	42	49	61	55	60	66	66	66	65	61	46	40		56
MEAN SKY COVER (tenths)															
Sunrise to Sunset	44	7.3	7.0	7.0	6.6	6.3	5.9	5.7	5.3	5.3	5.3	6.6	7.1		6.3
MEAN NUMBER OF DAYS:															
Sunrise to Sunset:															
-Clear	44	5.7	5.8	5.9	6.4	7.6	7.8	8.0	10.2	10.5	11.6	7.5	6.3		93.2
-Partly Cloudy	44	5.7	6.4	7.6	8.9	9.4	11.3	12.7	11.4	8.9	7.6	6.0	5.7		102.2
-Cloudy	44	19.6	16.0	17.5	14.9	14.0	10.9	10.3	9.4	10.6	11.8	16.3	18.6		169.8
Precipitation															
.01 inches or more	44	11.3	10.7	12.9	11.8	11.7	9.8	10.5	8.4	8.0	7.6	10.3	11.4		124.3
Snow, ice pellets, hail															
1.0 inches or more	44	1.7	1.2	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.7		4.6
Thunderstorms	44	0.8	1.0	3.1	4.3	6.7	7.3	8.2	6.8	3.3	1.7	1.4	0.6		45.3
Heavy fog visibility 1/4 mile or less	44	0.9	0.8	0.5	0.2	0.3	0.3	0.5	0.9	1.0	1.5	0.7	0.7		8.4
Temperature °F															
-Maximum															
90° and above	31	0.0	0.0	0.0	0.1	0.5	6.1	11.3	9.4	3.1	0.0	0.0	0.0		30.5
32° and below	31	9.0	5.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	4.4		19.3
-Minimum															
32° and below	31	24.3	19.9	11.8	2.2	0.1	0.0	0.0	0.0	0.0	1.5	9.0	20.2		89.0
0° and below	31	1.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4		1.9
AVG. STATION PRESS (mb)	19	1002.5	1001.6	998.9	997.9	997.3	997.9	998.8	999.5	1000.4	1001.5	1001.4	1002.4		1000.0
RELATIVE HUMIDITY (%)															
Hour 01	31	72	72	69	68	77	79	81	82	83	78	74	73		76
Hour 07 (Local Time)	31	76	77	75	76	82	83	85	87	88	85	79	77		81
Hour 13	31	64	61	57	52	55	56	58	58	59	55	60	64		58
Hour 19	31	65	62	57	52	57	58	60	61	63	61	64	67		61
PRECIPITATION (inches):															
Water Equivalent															
-Normal		3.38	3.23	4.73	4.11	4.15	3.60	4.10	3.31	3.35	2.63	3.49	3.48		43.56
-Maximum Monthly	44	11.38	9.02	14.91	11.10	11.57	10.11	10.05	8.79	10.49	6.47	9.12	8.86		14.91
-Year		1950	1989	1964	1970	1990	1960	1979	1974	1979	1983	1957	1990		MAR 1964
-Minimum Monthly	44	0.45	0.76	1.02	0.76	1.37	0.49	0.99	0.23	0.27	0.39	0.72	0.65		0.23
-Year		1981	1978	1966	1976	1977	1984	1983	1953	1953	1987	1976	1976		AUG 1953
-Maximum in 24 hrs	44	3.00	3.66	6.97	4.85	4.60	5.14	5.46	3.05	4.97	3.25	3.58	2.79		6.97
-Year		1988	1990	1964	1970	1961	1960	1979	1970	1979	1977	1948	1978		MAR 1964
Snow, Ice pellets, hail															
-Maximum Monthly	44	28.4	13.1	22.9	1.6	T	0.0	0.0	0.0	0.0	1.4	13.2	9.3		28.4
-Year		1978	1948	1960	1973	1989					1989	1966	1961		JAN 1978
-Maximum in 24 hrs	44	14.1	11.0	12.1	1.6	T	0.0	0.0	0.0	0.0	1.4	13.0	5.0		14.1
-Year		1978	1966	1968	1973	1989					1989	1966	1961		JAN 1978
WIND:															
Mean Speed (mph)	44	9.6	9.6	10.3	9.8	8.0	7.4	6.8	6.5	6.8	7.3	8.9	9.3		8.4
Prevailing Direction through 1963		S	NW	NW	SW	SE	S	S	N	SE	SE	S	S		S
Fastest Obs. 1 Min.															
-Direction (!!!)	6	W	30	22	33	27	27	32	32	29	18	25	29		32
-Speed (MPH)	6	34	32	36	37	35	41	46	26	39	26	33	31		46
-Year		1984	1990	1986	1988	1985	1985	1987	1986	1986	1990	1988	1984		JUL 1987
Peak Gust															
-Direction (!!!)	8	W	NW	NW	S	S	W	NW	S	NW	SE	W	S		NW
-Speed (mph)	8	48	52	60	49	60	72	78	53	48	44	45	52		78
-Date		1990	1990	1986	1985	1985	1990	1987	1984	1984	1984	1988	1987		JUL 1987

(!!!) See Reference Notes on Page 68.

PRECIPITATION (inches)

LOUISVILLE, KENTUCKY

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1962	4.03	5.58	3.58	[illegible]	[illegible]	4.75	[illegible]	[illegible]	3.55	4.70	[illegible]	2.74	39.91
1963	[illegible]	[illegible]	3.04	[illegible]	4.35	4.18	[illegible]	[illegible]	3.48	0.81	[illegible]	[illegible]	38.44
1964	[illegible]	[illegible]	[illegible]	3.76	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.32	5.86	46.58
1965	[illegible]	[illegible]	4.92	3.09	[illegible]	[illegible]	4.86	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39.80
1966	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.33	44.92
1967	[illegible]	[illegible]	4.37	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.08	3.51	43.92
1968	[illegible]	[illegible]	[illegible]	3.94	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.34	3.62	37.28
1969	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.08	3.69	36.79
1970	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.18	52.21
1971	2.64	[illegible]	[illegible]	[illegible]	[illegible]	2.64	[illegible]	[illegible]	[illegible]	[illegible]	2.06	2.98	42.29
1972	2.87	3.94	[illegible]	[illegible]	4.46	[illegible]	3.64	[illegible]	[illegible]	2.55	6.31	5.29	49.38
1973	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.34	2.28	[illegible]	53.97
1974	4.38	[illegible]	[illegible]	[illegible]	3.86	2.38	2.04	[illegible]	[illegible]	2.09	3.03	2.85	42.93
1975	4.87	4.53	[illegible]	6.47	4.50	3.15	[illegible]	3.89	2.64	[illegible]	3.69	4.89	56.31
1976	3.85	3.13	2.87	[illegible]	5.09	4.71	2.10	3.18	3.10	3.99	0.72	0.65	34.15
1977	2.33	1.45	4.68	3.40	[illegible]	[illegible]	3.29	[illegible]	3.67	4.76	6.11	4.32	49.10
1978	5.90	2.76	3.76	3.33	4.76	2.67	[illegible]	5.50	0.96	2.26	5.14	[illegible]	46.45
1979	3.81	4.49	[illegible]	[illegible]	3.59	3.03	10.05	2.37	0.49	2.27	5.85	3.82	59.80
1980	[illegible]	1.09	4.80	2.63	4.58	3.70	5.41	3.76	3.17	3.37	2.42	1.25	37.89
1981	0.45	3.23	1.54	4.44	4.63	3.23	3.98	3.21	3.22	1.60	2.40	2.02	33.95
1982	5.28	1.55	5.89	3.05	2.96	3.86	3.72	3.74	3.46	1.26	5.50	5.11	45.38
1983	1.63	1.52	2.16	[illegible]	10.58	4.42	0.99	2.39	[illegible]	6.47	5.03	3.96	47.38
1984	0.92	1.68	4.41	5.53	6.79	0.49	6.94	5.08	3.70	2.12	5.87	5.86	49.38
1985	2.23	2.08	4.43	1.69	3.93	4.37	3.45	4.49	[illegible]	4.24	4.43	0.96	37.75
1986	0.91	3.90	2.69	[illegible]	4.28	2.32	[illegible]	2.19	2.75	3.08	4.62	2.69	37.51
1987	0.81	4.42	3.05	2.35	1.61	3.58	5.31	2.66	1.15	0.39	2.62	4.70	32.65
1988	4.00	3.58	2.97	3.52	2.58	0.87	4.68	3.00	1.48	1.54	5.76	3.45	37.53
1989	3.68	9.02	5.50	4.93	4.39	5.26	6.90	2.20	2.42	2.65	2.57	1.45	50.97
1990	3.90	6.72	2.78	3.46	11.57	6.13	1.96	3.21	2.57	3.97	2.34	8.86	57.47
1991	3.29	3.72	4.79	2.61	4.02	[illegible]	2.99	3.35	2.74	2.31	1.87	5.23	38.15
Record Mean	3.76	3.39	4.49	3.93	4.00	3.81	3.82	3.28	2.79	2.60	3.51	3.61	42.99

See Reference Notes on Page 68

AVERAGE TEMPERATURE (deg. F)

LOUISVILLE, KENTUCKY

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1962	30.5	39.1	42.3	53.1	71.4	73.4	76.2	76.4	65.0	59.3	44.2	30.3	55.1
1963	26.1	30.2	49.5	59.0	63.3	73.0	74.8	73.4	66.8	63.5	48.4	26.7	54.6
1964	35.9	33.4	45.3	58.4	66.8	75.1	76.4	76.2	69.1	53.4	48.0	38.0	56.3
1965	34.3	35.9	38.9	58.3	70.0	73.4	76.3	75.2	70.5	55.7	47.3	42.3	56.5
1966	27.1	34.1	46.1	53.4	62.3	73.1	81.1	75.6	67.4	54.6	47.2	35.6	54.8
1967	36.3	30.9	50.6	59.7	62.4	73.4	74.5	72.2	65.7	57.2	42.7	39.4	55.4
1968	30.3	30.1	45.7	56.8	63.4	74.0	77.7	77.9	69.0	57.4	48.0	35.7	55.5
1969	33.1	36.9	39.9	58.0	66.2	73.5	78.7	74.7	67.5	57.3	43.3	33.5	55.2
1970	27.9	33.6	42.3	59.3	67.2	72.9	75.8	76.0	73.4	58.1	45.3	39.6	56.0
1971	30.9	35.0	42.0	54.7	61.5	76.5	74.8	74.1	72.2	64.4	47.0	45.1	56.5
1972	35.2	34.9	44.8	56.2	65.5	70.6	77.1	76.1	72.3	55.3	44.0	39.1	55.9
1973	35.0	36.4	53.7	54.4	61.5	75.6	78.4	77.0	73.6	62.3	49.8	37.1	57.9
1974	39.8	39.3	49.8	57.2	65.1	68.7	75.9	75.0	63.2	54.9	47.0	39.1	56.3
1975	38.1	40.2	43.3	54.4	69.0	75.4	77.7	79.3	66.2	59.4	50.6	38.9	57.7
1976	31.3	45.4	52.4	57.5	62.9	72.9	76.8	74.2	68.8	52.5	39.5	33.1	55.4
1977	18.6	36.9	51.7	60.3	71.2	73.9	80.2	77.5	72.5	55.5	49.6	34.6	56.9
1978	22.9	23.8	41.7	58.0	63.8	75.7	78.5	77.1	73.7	55.5	50.0	40.0	55.1
1979	24.6	28.0	48.3	55.0	64.2	73.9	75.3	76.1	69.4	58.2	46.9	39.2	54.9
1980	33.5	29.6	41.8	53.6	66.8	73.4	81.5	81.0	73.5	58.8	46.3	30.3	56.3
1981	30.4	38.8	45.7	62.4	62.9	76.2	78.8	76.1	67.7	56.5	47.4	33.8	56.4
1982	28.6	34.9	47.1	51.3	70.3	69.3	78.0	73.5	66.8	[illegible]	[illegible]	44.9	56.0
1983	34.7	37.5	[illegible]	51.7	62.1	73.4	81.1	81.7	71.0	59.1	47.8	28.4	56.3
1984	28.9	41.5	[illegible]	55.0	62.6	77.7	75.5	76.0	67.2	63.9	[illegible]	49.9	58.6
1985	25.4	32.8	[illegible]	60.3	66.5	72.1	77.2	74.8	69.2	61.4	53.7	30.4	56.3
1986	34.5	39.9	[illegible]	58.5	67.0	75.7	80.3	74.3	73.1	59.5	45.9	[illegible]	57.8
1987	33.7	39.5	[illegible]	55.4	71.5	76.2	78.9	78.2	71.2	52.6	[illegible]	[illegible]	58.0
1988	31.0	34.7	[illegible]	57.0	67.1	75.6	80.3	80.0	70.1	52.3	47.8	[illegible]	[illegible]
1989	41.6	34.0	[illegible]	56.7	62.6	73.5	78.1	76.6	69.4	58.4	46.7	[illegible]	[illegible]
1990	43.1	44.3	51.2	55.5	64.2	75.1	78.5	77.5	71.8	58.7	52.0	[illegible]	59.4
1991	34.1	40.5	49.4	60.3	73.1	78.3	81.3	79.2	71.7	61.5	45.0	41.4	59.2
Record Mean	34.2	36.7	45.8	56.4	66.0	74.6	78.4	76.8	70.3	58.7	46.5	37.2	56.8
Max	42.1	45.2	55.1	66.4	76.1	84.4	88.2	86.6	80.5	69.1	55.2	48.0	66.2
Min	26.2	28.2	36.4	46.3	55.9	64.8	68.6	66.9	60.2	48.3	37.8	29.3	47.4

See Reference Notes on Page 68

HEATING DEGREE DAYS Base 65 deg F — LOUISVILLE, KENTUCKY

SEASON	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	TOTAL
1962-63	0	0	35	224	[illegible]	[illegible]	1200	868	476	231	139	1	[illegible]
1963-64	0	0	[illegible]	86	493	1178	895	910	603	215	55	1	4514
1964-65	0	3	41	345	502	829	943	808	802	223	200	0	4525
1965-66	0	2	45	304	526	697	[illegible]	951	580	383	127	8	4669
1966-67	0	0	35	224	531	907	882	949	453	219	139	3	4442
1967-68	0	0	58	259	660	788	1069	1017	590	247	98	4	4790
1968-69	0	0	48	176	571	903	981	778	711	213	51	4	4525
1969-70	0	0	42	282	645	971	1141	815	597	200	70	0	4923
1970-71	0	0	13	220	582	781	1052	833	701	303	137	0	4635
1971-72	0	0	13	65	537	610	914	866	623	282	61	19	3990
1972-73	0	0	16	298	628	793	927	796	349	343	129	0	4279
1973-74	0	0	3	144	450	860	772	714	481	257	99	19	[illegible]
1974-75	0	0	22	314	543	794	830	688	665	333	22	0	[illegible]
1975-76	0	0	13	205	431	901	1040	562	405	266	11	0	3895
1976-77	0	0	29	393	757	982	1435	780	421	183	36	7	5023
1977-78	0	0	6	295	472	935	1294	1145	720	221	142	1	5231
1978-79	0	0	4	293	442	765	1246	1030	514	301	94	5	[illegible]
1979-80	0	0	19	244	534	792	969	1021	713	342	68	8	[illegible]
1980-81	0	0	12	309	555	821	1065	728	595	142	122	0	4349
1981-82	0	0	61	268	523	960	1124	837	549	408	13	3	4746
1982-83	0	1	55	246	495	624	933	763	571	399	121	5	4214
1983-84	0	0	54	196	509	1128	1115	673	757	315	141	0	4888
1984-85	0	0	13	84	623	584	1222	896	458	180	52	6	4188
1985-86	0	0	53	160	347	1067	941	696	516	224	69	0	4073
1986-87	0	2	5	210	570	869	962	706	526	294	21	0	4175
1987-88	0	0	9	377	423	762	1048	872	580	244	38	7	4360
1988-89	0	0	13	398	510	833	720	860	513	291	156	4	4298
1989-90	0	0	49	230	539	1222	672	574	445	320	82	13	4146
1990-91	0	0	34	229	387	745	949	677	482	167	27	0	3697
1991-92	0	0	52	168	590	725							

See Reference Notes on Page 68

COOLING DEGREE DAYS Base 65 deg. F — LOUISVILLE, KENTUCKY

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
1969	0	0	0	9	106	277	431	308	127	49	0	0	1307
1970	0	0	0	36	147	244	343	346	283	15	0	0	1414
1971	0	0	0	2	35	351	310	291	237	58	3	0	1287
1972	0	0	3	25	81	193	386	351	242	2	4	0	1287
1973	0	0	7	29	28	325	422	380	280	71	2	0	1544
1974	0	0	22	31	109	136	345	319	75	8	10	0	1055
1975	0	0	0	24	152	320	402	451	116	36	5	0	1506
1976	0	0	21	47	51	243	372	294	92	10	0	0	1130
1977	0	0	14	50	234	281	479	396	238	5	20	0	1717
1978	0	0	0	20	110	323	425	383	270	6	2	0	1539
1979	0	0	5	10	73	279	326	350	154	39	0	0	1236
1980	0	0	0	8	134	266	519	504	276	31	1	0	1739
1981	0	0	5	68	63	343	435	348	150	10	0	0	1422
1982	0	0	1	2	183	139	408	274	118	68	13	8	1214
1983	0	0	7	8	39	264	504	524	240	19	0	0	1605
1984	0	0	0	20	69	386	333	349	145	56	0	1	1359
1985	0	2	8	48	106	233	387	311	185	55	14	0	1349
1986	0	0	5	37	138	330	481	306	255	46	0	0	1598
1987	0	0	0	14	232	342	439	416	203	1	4	0	1651
1988	0	0	4	10	111	333	481	472	173	10	0	0	1594
1989	0	0	6	48	88	264	412	364	188	30	0	0	1400
1990	0	0	22	44	65	323	427	392	244	42	7	0	1566
1991	0	0	8	31	286	406	514	445	262	68	0	0	2020

See Reference Notes on Page 68.

SNOWFALL (inches)

LOUISVILLE, KENTUCKY

SEASON	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	TOTAL
1952-53	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1953-54	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30.[illegible]
1954-55	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.4
1955-56	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20.[illegible]
1956-57	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	31.2
1957-58	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	31.0
1958-59	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13.1
1959-60	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	34.4
1960-61	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.5
1961-62	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].6
1962-63	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.5
1963-64	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.2
1964-65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.5
1965-66	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]
1966-67	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	24.0
1967-68	[illegible]	[illegible]	[illegible]	[illegible]	4.8	2.2	28.4	5.3	3.4	[illegible]	[illegible]	[illegible]	50.[illegible]
1968-69	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20.3
1969-70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.6	3.9	[illegible]	[illegible]	[illegible]	18.3
1970-71	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.9
1971-72	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].0
1972-73	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.5	[illegible]	[illegible]	[illegible]	[illegible]	5.2
1973-74	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.[illegible]	8.8	[illegible]	[illegible]	[illegible]	[illegible]	13.5
1974-75	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.8	[illegible]	6.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18.9
1975-76	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.[illegible]	8.8	[illegible]	[illegible]	[illegible]	[illegible]	11.6
1976-77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.2	6.[illegible]	9.3	[illegible]	[illegible]	[illegible]	18.2
1977-78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.0	5.0	[illegible].5	[illegible]	[illegible]	[illegible]	8.5
1978-79	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].9
1979-80	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].3	5.5	1.9	0.8	4.1	[illegible]	[illegible]	14.7
1980-81	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].0	4.[illegible]	0.3	1.5	[illegible].2	[illegible].0	[illegible]	[illegible]	6.1
1981-82	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].5	[illegible].1							
Record Mean	[illegible].0	[illegible].0	[illegible].0	T	[illegible].1	2.1	5.3	4.3	3.3	[illegible].1	T	[illegible].0	[illegible].3

See Reference Notes on Page 6B

REFERENCE NOTES

LOUISVILLE, KENTUCKY

GENERAL
T - TRACE AMOUNT
BLANK ENTRIES DENOTE MISSING UNREPORTED DATA
# INDICATES A STATION OR INSTRUMENT RELOCATION
SEE STATION LOCATION TABLE ON PAGE 8

SPECIFIC
PAGE 2
PM - INCLUDES LAST DAY OF PREVIOUS MONTH

PAGE 3
a - LENGTH OF RECORD IN YEARS, ALTHOUGH INDIVIDUAL MONTHS MAY BE MISSING.
0 # OR # THE VALUE IS BETWEEN 0.0 AND 0.05
NORMALS - BASED ON THE 1951-1980 RECORD PERIOD
EXTREMES - DATES ARE THE MOST RECENT OCCURRENCE
WIND DIR - NUMERALS SHOW TENS OF DEGRESS CLOCKWISE FROM TRUE NORTH. '00' INDICATES CALM.
RESULTANT DIRECTIONS ARE GIVEN TO WHOLE DEGREES.

PAGE 4B
RECORD = PERIOD OF RECORD
RECORD MEAN PRECIPITATION IS THE MEAN OF ALL DAILY PRECIPITATION AMOUNTS DURING THE PERIOD OF RECORD
RECORD MAX(MIN) TEMPERATURE IS THE MEAN OF ALL DAILY MAX (MIN) TEMPERATURES DURING THE PERIOD OF RECORD
RECORD MEAN TEMPERATURE IS THE DIFFERENCE BETWEEN THE RECORD MAX AND RECORD MIN DIVIDED BY 2.
AVERAGE TEMPERATURE IS THE DIFFERENCE BETWEEN THE MEAN DAILY MAX AND MIN TEMPERATURE DIVIDED BY 2.

EXCEPTIONS

PAGES 4A, 4B, 6A
RECORD MEANS ARE THROUGH THE CURRENT YEAR, BEGINNING IN 1873 FOR TEMPERATURE
1873 FOR PRECIPITATION
1948 FOR SNOWFALL

LOUISVILLE, KENTUCKY

Louisville is located on the south bank of the Ohio River, 604 miles below Pittsburgh, Pennsylvania, and 377 miles above the mouth of the river at Cairo, Illinois. The city is divided by Beargrass Creek and its south fork into two portions with entirely different types of topography. The eastern portion is rolling, containing several creeks, and consists of plateaus and rolling hillsides. The highest elevation in this area is 565 feet. The western portion is mostly flat with an average elevation about 100 feet lower than the eastern area. Much of the western section lies in the flood plain of the Ohio River. Nearly all of the industries in the city are located in the western portion, while the eastern portion is almost entirely residential. A range of low hills about five miles northwest of Louisville, on the Indiana side of the Ohio River, present a partial barrier to arctic blasts in the winter months. During colder months, snow is frequently observed on the summits of these hills when there is no snow in the city of Louisville or in riverside communities on the Indiana side of the Ohio River.

The climate of Louisville, while continental in type, is of a variable nature because of its position with respect to the paths of high and low pressure systems and the occasional influx of warm moist air from the Gulf of Mexico. In winter and summer there are occasional cold and hot spells of short duration. As a whole, winters are moderately cold and summers are quite warm. Temperatures of 100 degrees or more in summer and zero degrees or less in winter are rare.

Thunderstorms with high rainfall intensities are common during the spring and summer months. The precipitation in Louisville is nonseasonal and varies from year to year. The fall months are usually the driest. Generally, March has the most rainfall and October the least. Snowfall usually occurs from November through March. As with rainfall, amounts vary from year to year and month to month. Some snow has also been recorded in the months of October and April. Mean total amounts for the months of January, February, and March are about the same with January showing a slight edge in total amount. Relative humidity remains rather high throughout the summer months. Cloud cover is about equally distributed throughout the year with the winter months showing somewhat of an increase in amount. The percentage of possible sunshine at Louisville varies from month to month with the greatest amount during the summer months as a result of the decreasing sky cover during that season. Heavy fog is unusual and there is only an average of 10 days during the year with heavy fog and these occur generally in the months of September through March.

The average date for the last occurrence in the spring of temperatures as low as 32 degrees is mid-April, and the first occurrence in the fall is generally in late October.

The prevailing direction of the wind has a southerly component and the velocity averages under 10 mph. The strongest winds are usually associated with thunderstorms.

STATION LOCATION

LOUISVILLE, KENTUCKY

LOCATION	OCCUPIED FROM	OCCUPIED TO	AIRLINE DISTANCES AND DIRECTIONS FROM PREVIOUS LOCATION	LATITUDE NORTH	LONGITUDE WEST	ELEVATION ABOVE SEA LEVEL: GROUND TEMPERATURE	ELEVATION ABOVE GROUND: SITE	WIND INSTRUMENTS	EXTREME THERMOMETERS	PSYCHROMETER	SUNSHINE SWITCH	TIPPING BUCKET	RAIN GAGE	WEIGHING RAIN GAGE	8 INCH RAIN GAGE	HYGROTHERMOMETER	AUTOMATIC OBSERVING	EQUIPMENT *	REMARKS
CITY - - NOTE: For period September 10, 1871 through February 29, 1872, refer to previous editions.																			
4th Floor, Corner Main & Bullit Streets	2/29/72	3/3/77	1200 ft.NW	38° 15'	85° 45'	457	85E	62E						70E					Thermometers in window shelter. E - Estimated.
Courier-Journal Bldg. 6th Floor, SE Corner 4th & Green Streets	3/3/77	5/1/93	1000 ft. SSE	38° 15'	85° 45'	463	118	91	90		101			104					Thermometers moved to roof on 2/1/86 with extreme thermometers and psychrometer at 102' above ground thereafter.
4th Floor, NE Corner 4th & Chestnut Streets	5/1/93	1/21/13	1300 ft. S	38° 15'	85° 45'	459	132	111	111		103			103					
16th Floor, NE Corner 5th & Jefferson Streets	1/21/13	6/29/24	1600 ft. NNW	38° 15'	85° 45'	463	255	219	219		214			214					Equipment on roof. Shelter at base of 40' tower.
10th & 15th Floor, NW Corner 4th & Market Sts	6/29/24	4/29/39	300 ft. NE	38° 15'	85° 45'	466	234	188	188		183			183					
6th Floor, Federal Bldg 6th & 7th Streets and Broadway	4/29/39	1/18/55	3/4 mi.SSW	38° 15'	85° 46'	457	120	106	106		106		6	6					Tipping bucket gage and sunshine switch moved to airport 6/30/45.
AIRPORT Administration Building Bowman Field 5.5 mi. ESE of P.O.	5/7/30	11/20/33		38° 13'	85° 40'	539	a48	6	5										a - 44 ft. to 5/29/31. Temperatures taken over sod.
Administration Building Bowman Field	11/20/33	1/16/39		38° 13'	85° 40'	539	b56	19	18					17					b - 48 ft. to 7/1/37. Temperatures taken over gravel black top roof at 2nd floor level.
Administration Building Bowman Field	1/16/39	12/1/47		38° 13'	85° 40'	539	56	6	5		#5	5		5					Temperatures taken over sod. # Installed 7/1/45.
Wooden Hangar Standiford Field 5 miles SSE of P.O.	11/15/47	9/19/50	4.5 mi. SW	38° 11'	85° 44'	485	59	45	44		42	42		42					Temperatures taken over black top roof.
Lee Terminal Building Standiford Field	9/19/50	7/29/81	0.7 mi. NW	38° 11'	85° 44'	f477	c20	17	17	320	17 g15	17 g15		e15 g15	d6		NA		Temperatures taken over black gravel roof to 6/1/60. c - 71 feet to 5/7/60. d - Commissioned about 2050 feet SSE of thermometer site 6/1/60. e - Removed 7/1/51; installed again 11/20/60. f - 474 feet to 6/1/60. g - Effective 5/14/71. % - Commissioned 9/27/74.
NWS/FAA Building Standiford Field	7/29/81	Present	0.88 mi.SE	38° 11'	85° 44'	477	h22	5	5	h20 17	1	1		1	h6 j4		NA		h - Not moved 7/29/81. i - Moved to new site 8/2/81. j - Effective 10/8/81.

SUBSCRIPTION:
Price and ordering information available through: National Climatic Data Center, Federal Building, Asheville, North Carolina 28801.
USCOMM-NOAA-ASHEVILLE, N.C. - 570

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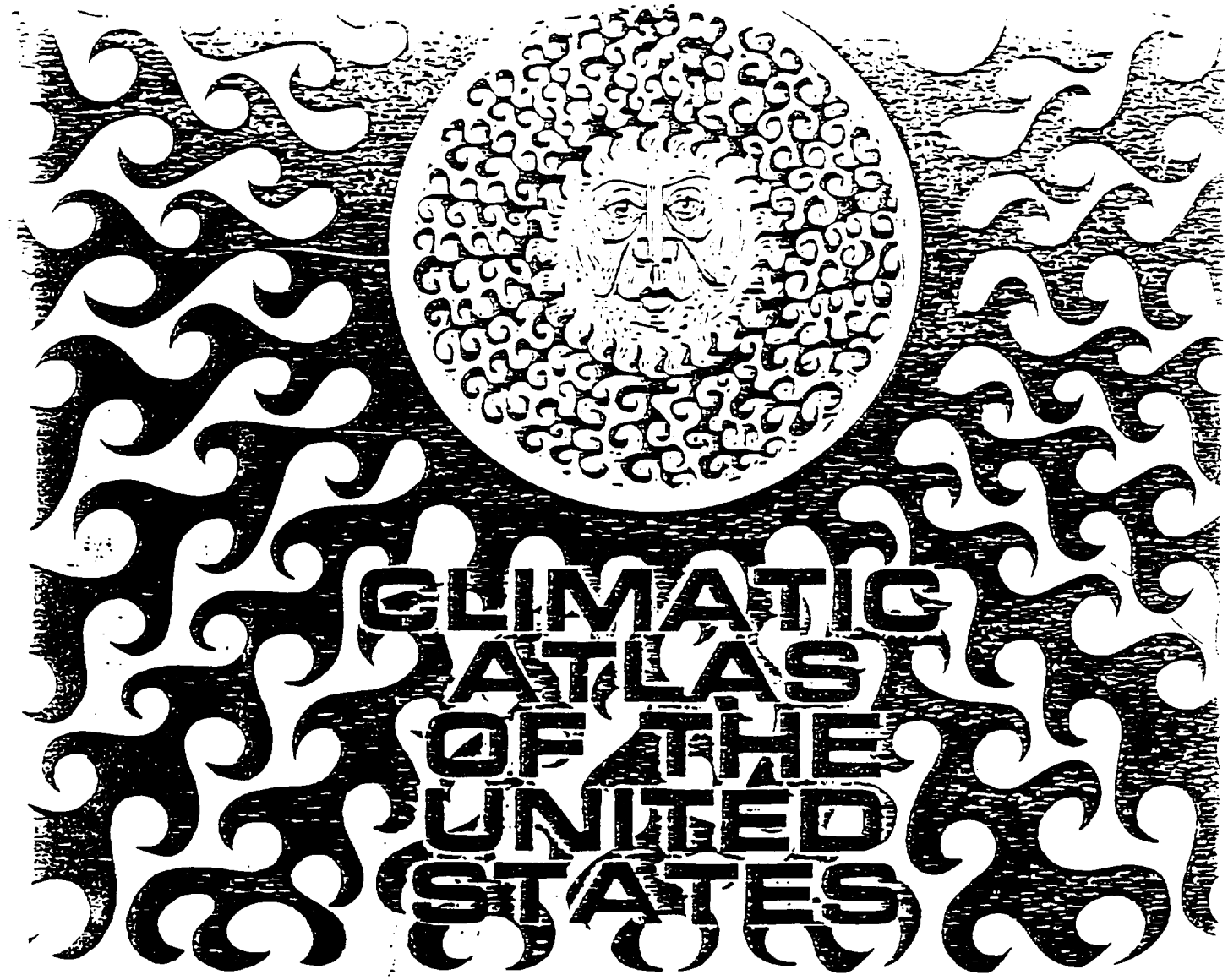

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U.S. DEPARTMENT OF COMMERCE
C. R. Smith, Secretary

ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION
Robert M. White, Administrator

ENVIRONMENTAL DATA SERVICE
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JUNE 1968

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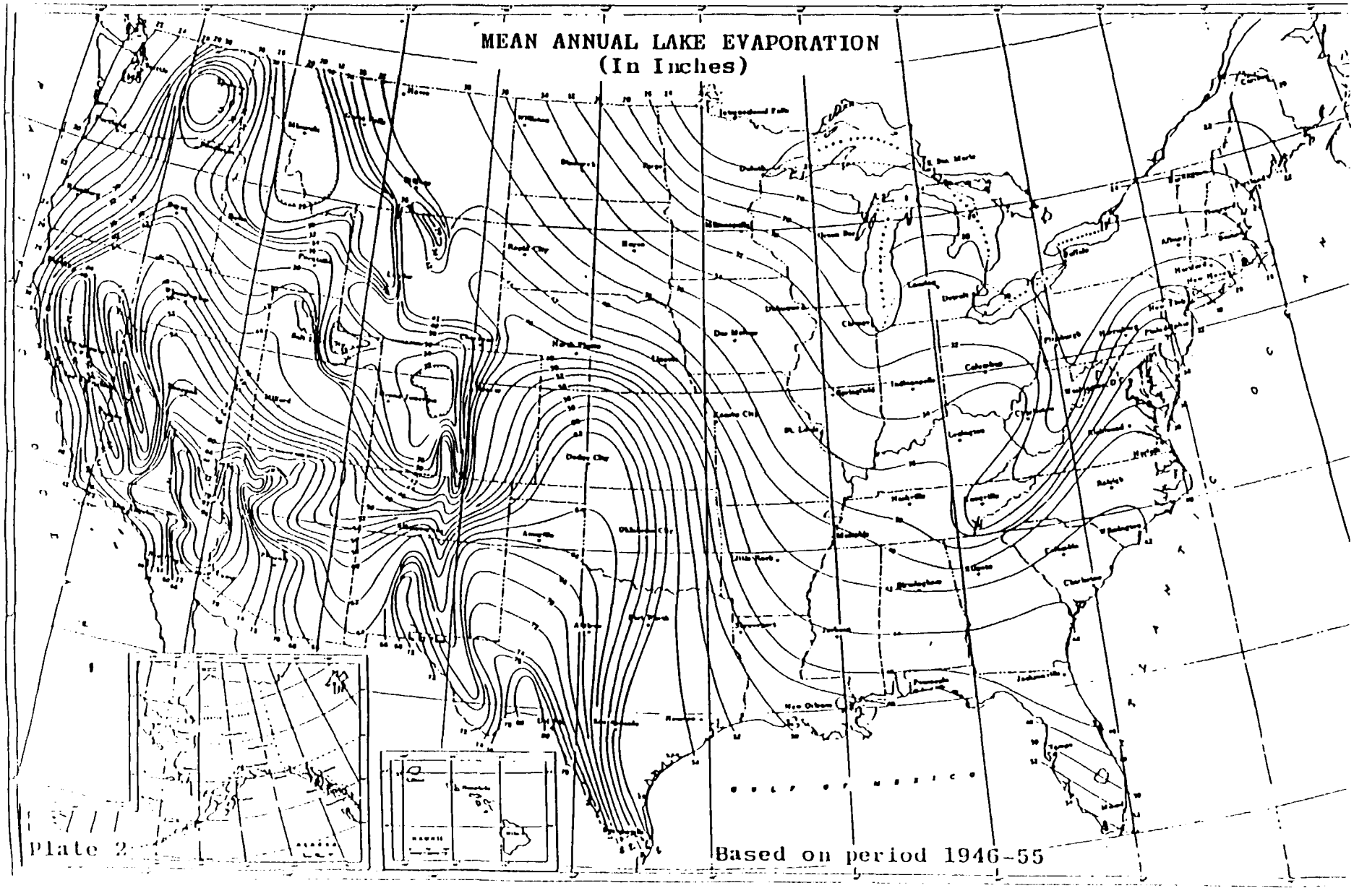


Plate 2

DEPARTMENT OF COMMERCE
[illegible] Hodges, Secretary

WEATHER BUREAU
[illegible]

TECHNICAL PAPER NO. 40

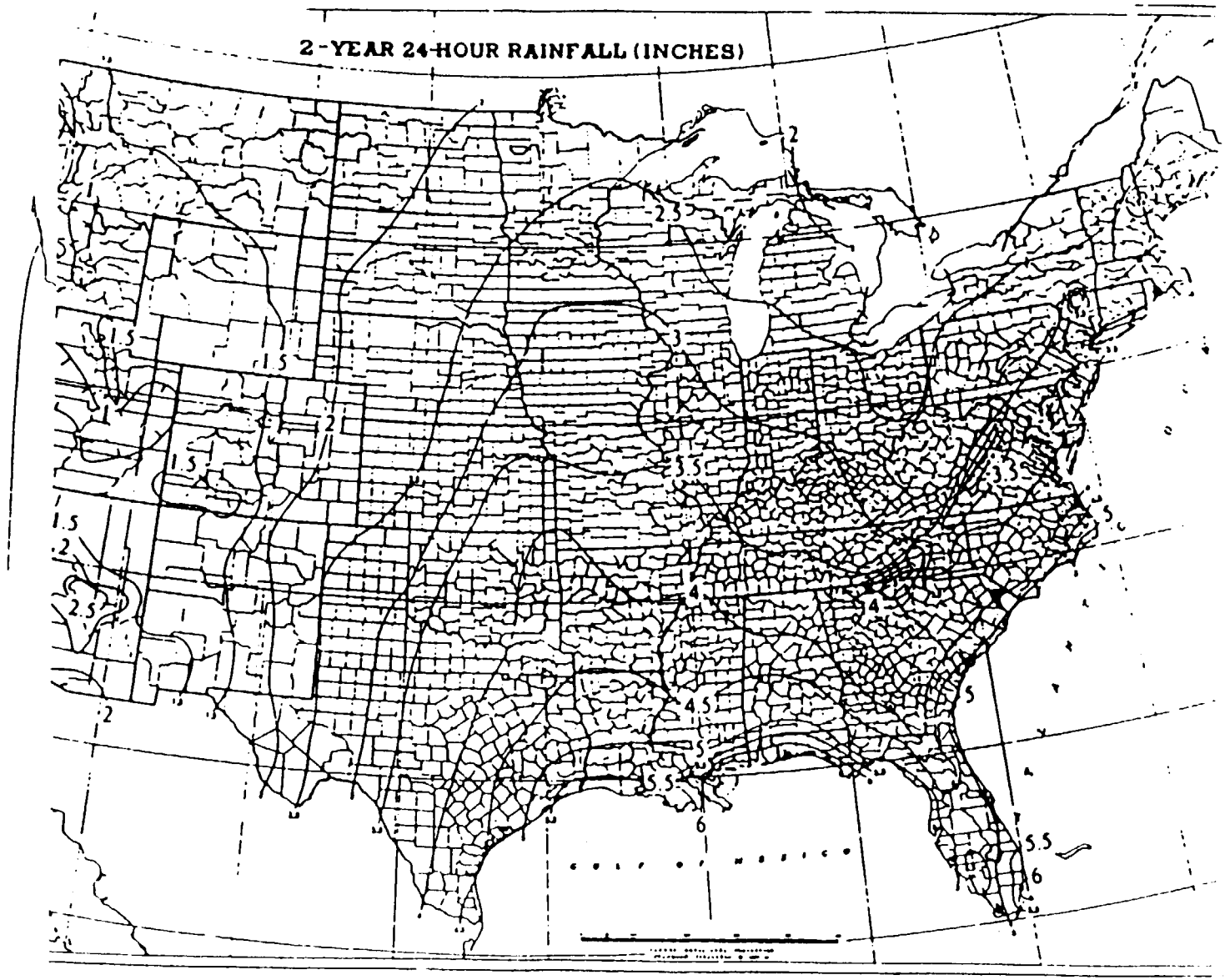
RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years

Prepared by
DAVID M. HERSHFIELD
Cooperative Studies Section, Hydrologic Services Division
for
Engineering Division, Soil Conservation Service
U.S. Department of Agriculture

PROPERTY OF EF
FIT IV

Reference 5


2-YEAR 24-HOUR RAINFALL (INCHES)
2
2.5
3
3.5
4
4.5
5
5.5
6
1.5

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1

TUES SEPT 14 1993

1120 - Arrive @ Jefferson Forest Drum site. Parked at locked gate, south ~~west~~ east side of a large fenced area. JRN 9/14/93 Access road to gate is off Letts Road. Letts Road intersects State Hwy 1020 N. of L&N golf course

1125 - PHOTO 1 ROLL 1 VIEW NW
Gate at SE end of access road
Note MW inside gate at right
Drainage culvert underlies roadway

1132 PHOTO 2 ROLL 1 VIEW SE
Access road to locked gate
Note residence to left in background; ~~stream~~ culvert JRN 9/14/93 crosses under access road to pond at right

1135 PHOTO 3 ROLL 1 VIEW NE
Pond S of gate

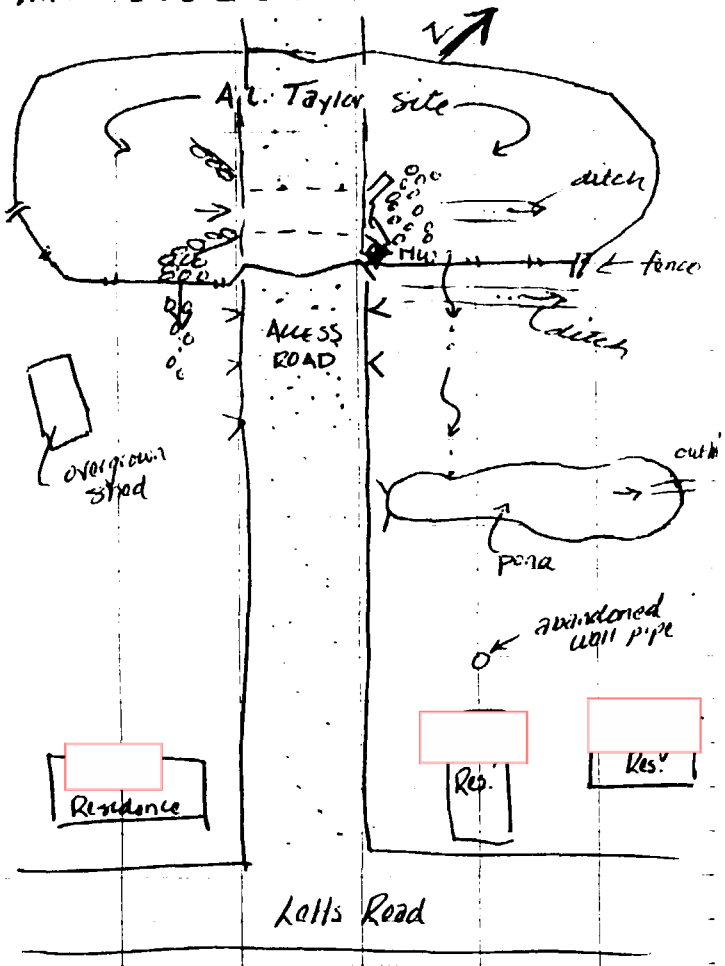
1138 PHOTO 4 ROLL 1 VIEW SSW
Overflow outlet of pond

1140 Drainage from pond flows

9/14/93 John P Nett

②

1127 SITE SKETCH



NOT TO SCALE

9/14/93

JMP

③

1140 (cont) NNW toward ditch area at perimeter of fence.

1143 PHOTO 5 ROLL 1 VIEW S

1145 - Resident stopped by. I informed him who I was & what my purpose was. ~~Bot~~ Three residences use cisterns for water supply. None of the homes on Lott Rd are on city water. Fenced area is A.L. Taylor site. on farmer to area

Larry Rutledge

JPN 9/14/93

1150 - Got ride into forest where drums were excavated. Area that was trenched is now overgrown.

1156 - PHOTO 6 ROLL 1 VIEW WSW Area where drums were excavated in 3/93 Note: scrap metal in right foreground

1202 PHOTO 7 ROLL 1 VIEW NE View of drum carcass & insulation material at bottom of embankment. JPN 9/14/93

1208 PHOTO 8 ROLL 1 VIEW NE View of drum carcass in embankment.

1209 - Trenching areas no longer discernable due to overgrowth

9/14/93

JMP

1210 PHOTO 9 ROLL 1 VIEW WNW
Debris at base of embankment
1211 PHOTO 10 ROLL 1 VIEW NE
Debris at base of embankment
1215 PHOTO 11 ROLL 1 VIEW NW
Debris w/in embankment
Note: brick & solidified material.
1217 PHOTO 12 ROLL 1 VIEW NW
Corroded 5 gallon bucket
1217 PHOTO 13 ROLL 1 VIEW NE
Drum carcasses & solidified material
1217 PHOTO 14 ROLL 1 VIEW NE
Drum carcasses & solidified material
1229 PHOTO 15 ROLL 1 VIEW NNW
Corroded empty 5 gallon bucket ~~of~~ (hydraulic fluid) JPK 9/14/93
1232 PHOTO 16 ROLL 1 VIEW WSW
Erosion of soil (overland drainage NE of embankment
1235 PHOTO 17 ROLL 1 VIEW NNE
Old fence (runs ENE)
Possible county boundary line?

9/14/93 [illegible]

1239 PHOTO 18 ROLL 1 VIEW W
View of access way (trail) into embankment area
Note: Photo taken near "No Paintballers" sign in tree noted in memorandum photo log 11/93 compiled by KDEP
1245 - Circular track area noted in state's memo is near sign in tree. Photo 16 was taken in the area of barren soil noted in memo. Could not find access way (trail) to RR.
1252 - Stream on topo flows NE (intermittent) SW of embankment
1300 - PHOTO 20 ROLL 1 VIEW NNW
View of KG&E access road
1303 - PHOTO 21 ROLL 1 VIEW ESE
View from KG&E access road across A.L. Taylor site
1310 - Arrived back at gate
1315 - [illegible]
Met him at his house and spoke w/ him. Property w/ drums was donated to

9/14/93 [illegible]

1315 (cont) Left to Memorial Forest
[redacted] - next to [redacted]
See site sketch — brick house
Water supply - cisterns
Previously well water
Switched over when activity
L&N golf course & brickyard
on city water - Louisville
Water Company
Water line parallels RR and
crosses Letts Rd to golf course
Mr Rutledge believed the site to
be located in Jefferson County.
1320 - Left site to go into Louisville

9/14/93

Reference 7

PHILLIP J. SHEPHERD
SECRETARY

BRERETON C. JONES
GOVERNOR

COMMONWEALTH OF KENTUCKY
NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
DEPARTMENT FOR ENVIRONMENTAL PROTECTION
FRANKFORT OFFICE PARK
14 REILLY ROAD
FRANKFORT, KENTUCKY 40601

November 30, 1992

Ms. Fleicia Barnett
U.S. Environmental Protection Agency
345 Courtland Street
Atlanta, GA 30365

Dear Ms. Barnett:

As per today's conversation, I am forwarding a copy of a field report and photographs relating to what appears to be a previously unaddressed disposal area at the A. L Taylor site in Brooks, Kentucky. As we also discussed, the EPA representative who will be coming to the site should contact this agency's Lajuanda Haight-Maybriar directly to make arrangements for this site visit. Please let me know if you require any further information.

Sincerely,

Carl Millanti, Manager
Superfund Branch

CM:kb

Attachments

c: C. Pat Haight
Rick Hogan
Lajuanda Haight-Maybriar
Curtis Evanoff
File

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M E M O R A N D U M

TO: Carl Millanti, Manager
Superfund Branch

THRU: Rick Hogan, Supervisor
Federal Superfund Section

FROM: Lajuanda Haight-Maybriar, Environmentalist
Federal Superfund Section

DATE: November 19, 1992

SUBJECT: A.L. Taylor Superfund Site
Brooks, Bullitt County, Kentucky

On November 13, 1992, Curtis Evanoff and I travelled to the A.L. Taylor site. The purpose of our visit was to gather information needed to complete a bid package for operations and maintenance work to be conducted at the site.

When we arrived on site, an adjacent property owner, greeted us and questioned us about the possibility of having the state or EPA defray the cost of installing city water lines to his and his neighbors' homes. We began discussing the past activities at the site and informed us there were still drums sticking out of the ground in a wooded area he indicated to be northeast of the site. said the heirs to that property had contacted another adjacent property owner, and offered to sell the property. refused and explained that the drums were present on the property. The heirs said they were not aware of this. Later, heard the property had been donated to the Jefferson Memorial Forest. We asked for directions to the area and he offered to escort us there.

We hiked through a wooded area to a circular area that Mr. said has been used as a track for motorcycles and four-wheelers. There was a barren mound of soil inside the circular area. The soil appeared to consist of mainly clay and rock and Mr. said that it had been barren as long as he had been walking in those woods. From the mound, we proceeded westward along a trail. We observed a warning sign on a tree near the trail that stated the area was a wildlife refuge which supported Mr. belief that the property had been donated to or purchased by the Jefferson Memorial Forest.

told us we were in the general area where the drums were located. From the trail, Mr. Evanoff observed a slope that did not appear natural. We left the trail and walked down the slope and over what appeared to be an embankment. We found an abandoned household appliance and various pieces of scrap metal there. We moved westward along the embankment and began to see

abandoned fully exposed and partially buried drums and an uncontained green solidified material that appeared to be paint waste.

The drums appeared to be very old and weathered and several had rusted through or contained bullet holes. One drum that was partially exposed had a small hole rusted through and was leaking a small amount of liquid material. Another drum that was fully exposed and lying on its side appeared to contain a liquid material but it had some small holes in the side opposite the side it was lying on. All other exposed drums appeared to be empty.

Due to the intended purpose of our visit, we did not have any monitoring equipment or a camera available. Therefore, we left the drum area and continued on through the woods. We emerged from the woods on the Louisville Gas and Electric (LG&E) maintenance road north of the site.

To return to the drum area, exit the site through the north gate and proceed north on the LG&E maintenance road to the third utility pole beyond the gate. Turn right (east) into the woods and follow the trail. The embankment where the drums are located will be on the right of the trail. If the circular track and barren mound of soil become visible, exit the trail to the right. This will be the top of the embankment and the drums will be visible at points along the edge.

On November 17, 1992, I received a phone call from Mr. [redacted] He said he had been talking with someone who had told him that Mr. Taylor used to own 100 acres in that area and the area where we found the buried drums is the original location of Mr. Taylor's operation. He said Mr. Taylor accessed the operation from Brooks Road and, after he sold off the front piece of the property, he moved his operation to the area where the Superfund remediation took place.

On November 18, 1992, Mr. Evanoff and I travelled to the site. We located an access road off of Brooks Road near the brickyard. There was no railroad crossing there but, when we walked across the tracks, we observed a raised fill area that appeared to be an old road bed. This road bed extended to the circular track area near the exposed drums but was intersected at one point by a small stream.

We returned to the drum area with a Microtip and a metal detector. With the Microtip, we walked along the embankment and scanned the drums we observed on November 13, 1992. The ambient reading was 0.0 and there were no unit deflections on this instrument in any of the areas scanned. We counted forty-four fully or partially exposed drums.

We scanned the barren mound of soil with the metal detector and observed very intense readings over most of the mound. In addition, we scanned the fill area between the trail and the

exposed drums in the face of the embankment. We also observed very intense readings at several points in this area.

We observed an additional embankment area beyond the area identified on November 13, 1992. This embankment extended for an additional 100 yards and appeared to contain mainly construction debris. However, we did observe some weathered drum remnants and in one area there were hundreds of tubes of Dow Corning Marine Sealant. These were the size of large toothpaste tubes. Also in this area, there were plastic buckets with a solidified mass of white material around them.

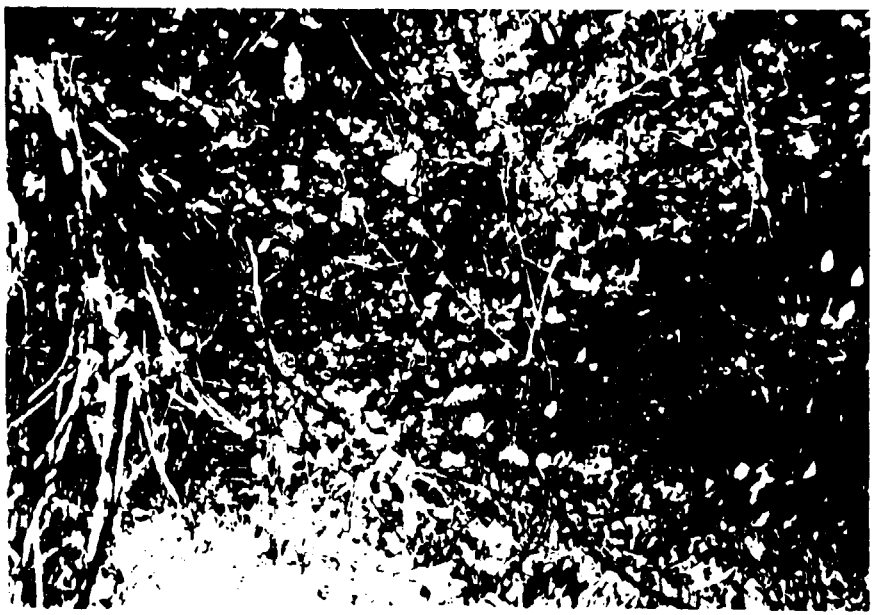
We photographed the barren mound and the exposed drums. After completing this task, we left the site and returned to Frankfort.

A.L. TAYLOR

Photographic Log

November 13 & 18, 1992

NO PAINTBALLERS



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ecology and environment, inc.

4319 COVINGTON HIGHWAY, DECATUR, GEORGIA 30035, TEL. 404-288-7711

International Specialists in the Environmental Sciences

September 21, 1982

Mr. R. D. Stonebraker, Deputy Chief
Hazardous Emergency Response Branch
Air and Hazardous Materials Division
Environmental Protection Agency
345 Courtland Street, N.E.
Atlanta, GA 30365

Subject: Feasibility Study of the A. L. Taylor Site
TDD # F4-8209-07

Dear Mr. Stonebraker:

In accordance with provisions of TDD # F4-8209-07 and modifications A through D, the Remedial Action Feasibility Study for the A. L. Taylor site is submitted for your approval.

This report has been changed from previous submittals in response to comments and requests made by Kentucky Department for Natural Resources and Environmental Protection and EPA personnel.

Section 7 presents the original recommendation concerning alternative selection. Section 8 presents response to comments made by EPA and Kentucky. The response to comments refine certain details to the report but do not materially effect the results except for alternative selection. Kentucky recommended a modified removal remedial action alternative be developed for consideration. This modified alternative is presented in Appendix C.

The alternative selection process has not been completed. Before concuring with Kentucky's recommendation to implement the modified removal alternative, EPA Headquarters asks for additional information on the integrity of the shale bedrock and the deep groundwater quality. This information is being developed from a deep test well drilling program under TDD # F4-8208-05 and will be completed in mid-December, 1982. After the test well data is analyzed and the remedial action alternative selected, the Conceptual Design of the preferred alternative will be completed under TDD # F4-8207-08.

This submission satisifies the requirement of TDD # F4-8109-07.

Sincerely,

James L. Templeton, Jr.

James L. Templeton, Jr.
FIT Leader, Region IV

JLT/lsr

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SECTION 1

BACKGROUND

The A. L. Taylor hazardous waste disposal site is an uncontrolled and inactive industrial waste dump located in Bullitt County, Kentucky. This site, also known as the "Valley of the Drums," is among the top 80 sites of the nation's 115 high priority sites recently announced by the U.S. Environmental Protection Agency (EPA) for cleanup using the "Superfund." This listing qualifies the A. L. Taylor site for remedial action under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund Act). Sections 104 and 105 of the Superfund Act require that the feasibility of alternative remedial actions be evaluated and the most cost-effective alternative which protects human health and welfare and the environment be selected for implementation.

1.1 SITE DESCRIPTION

The site was used by A. L. Taylor as a municipal refuse dump, a drum recycling center, and an industrial chemical dump from 1967 to 1977. The EPA conducted emergency cleanup actions in 1979 by authority of Section 311 of the Clean Water Act and in 1981 under the emergency provisions of the Superfund Act.

The site is located in a valley in north-central Bullitt County, Kentucky, just south of the Jefferson County line, west of Kentucky Highway 1020, and north of the Louisville and Nashville Golf Course (See Figure 1-1). The actual disposal site covers 13 acres of the 23-acre tract previously owned by Mr. Taylor. The surface features of the site have been substantially disturbed. Mr. Taylor excavated pits onsite, emptied the contents of drums into them, and recycled the drums. Soil from nearby hillsides was used to cover these pits. During its emergency response actions, the EPA modified the drainage patterns of the site to keep runoff from directly entering nearby Wilson Creek. Substantial areas of vegetation have been removed from the site as a result. Four or

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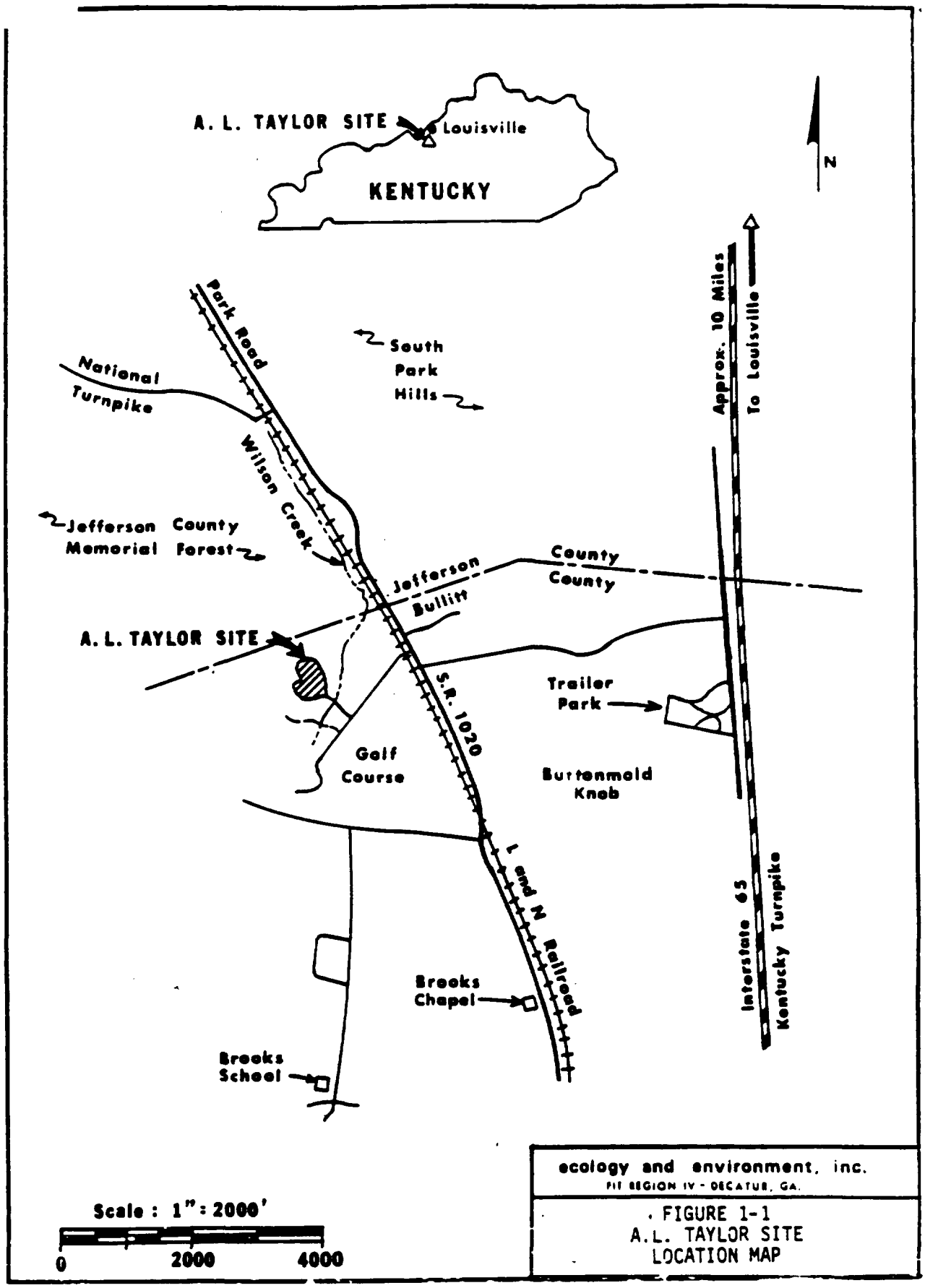

ecology and environment, inc.
FIT REGION IV - DECATUR, GA.

FIGURE 1-1
A.L. TAYLOR SITE
LOCATION MAP

five major cells of buried wastes containing chemical liquids, sludges and crushed drums have been discovered by surface geophysical investigations (see Figure 1-2).

To control the discharge of pollutants from the site, the EPA constructed a temporary wastewater treatment plant during the 1979 emergency response. This treatment plant was upgraded during the 1981 emergency action.

The runoff and leachate from the site are intercepted by trenches constructed along the south and east sides of the site and directed to a detention lagoon at the intersection of the trenches. The wastewater is pumped from the lagoon to a temporary treatment plant. In the first tank the wastewater is aerated and electrolyte added. The wastewater is then directed to a sedimentation basin, the supernatant from which is pumped through a pressure sand filter to an activated carbon filter and then to Wilson Creek. The sedimentation basin sludge, the pressure filter backwash and the carbon filter backwash are all returned by portable pumps to the detention lagoon. Both the sedimentation basin and the activated carbon filter are fabricated from steel tanks of the type used for garbage collection. The aeration tank is constructed from a galvanized stock tank.

A full description of the environmental setting of the site is presented in Section 3.

1.2 HISTORY OF RESPONSE ACTIVITIES

The A. L. Taylor site was first recognized as a waste disposal area by the Kentucky Department of Natural Resources and Environmental Protection (DNREP) in 1967. State personnel visited the site after open burning regulations had become effective, and reports were made about a fire on the site that had been burning for at least one week. Following this December, 1967, site visit, the State noted that an approved sanitary landfill could be operated by Mr. A. L. Taylor at this location with proper permitting. Mr. Taylor did not apply for a sanitary landfill permit, but continued receiving and disposing of wastes on the site until November, 1977.

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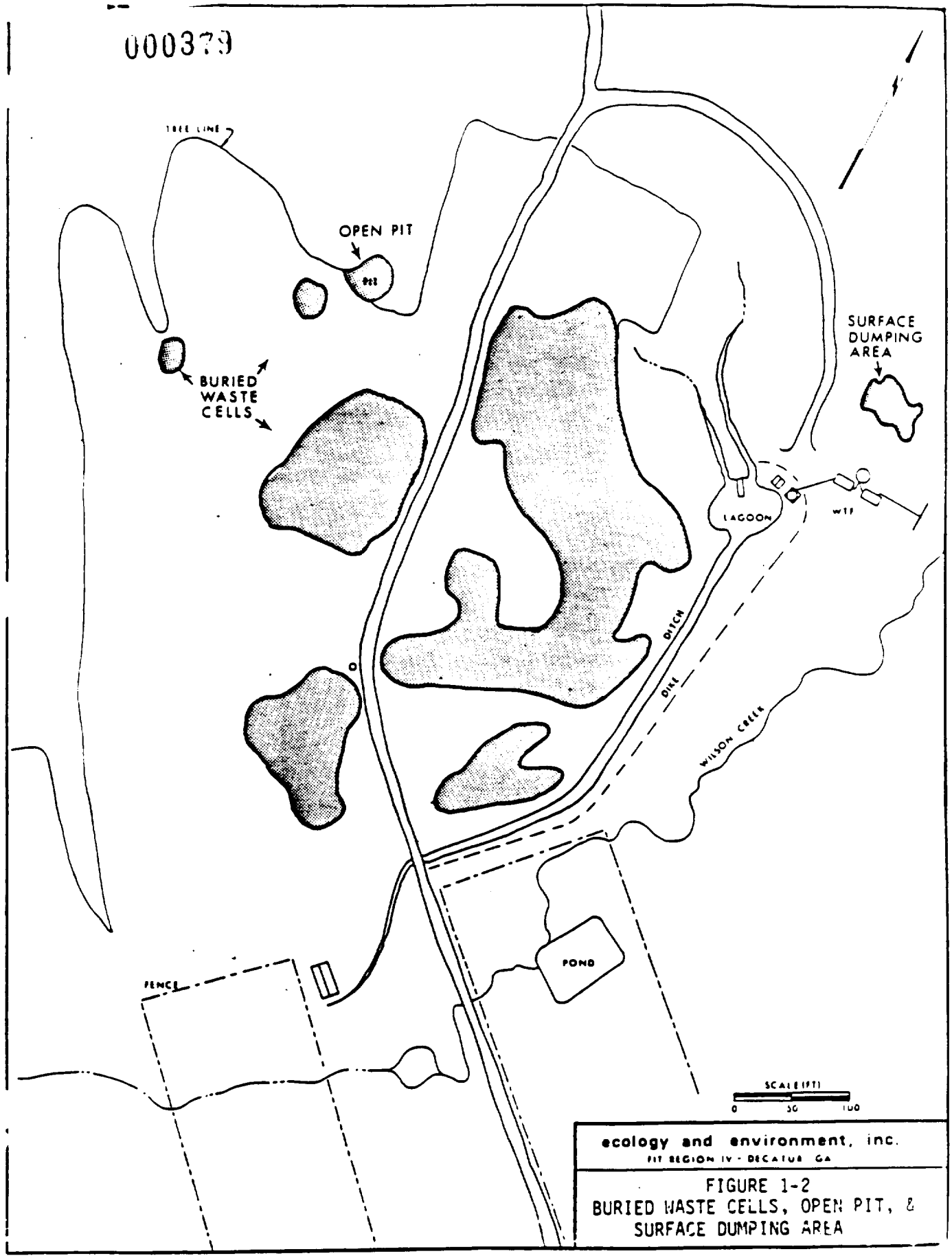

FIGURE 1-2
BURIED WASTE CELLS, OPEN PIT, & SURFACE DUMPING AREA

In 1975 the State began receiving complaints that pollutants allegedly originating from Mr. Taylor's disposal operation were entering Wilson Creek. The State Water Quality Division responded by obtaining samples from the creek for analysis of metals. The analytical results indicated pollution of Wilson Creek, and the site was referred to the Kentucky General Counsel for appropriate legal considerations in February, 1976.

A notice of complaint was filed in March, 1976, by the Kentucky DNREP against the A. L. Taylor Drum Cleaning Service that operated on the A. L. Taylor site. Mr. Taylor's operation was cited for three violations of discharging wastes into a stream without a National Pollutant Discharge Elimination System (NPDES) permit. By August, 1976, Mr. Taylor had removed almost all visible pollutants from Wilson Creek. Beginning in December, 1976, the State identified local industries employing Mr. Taylor to transport wastes to various disposal sites. A site visit in May, 1977, noted that Mr. Taylor was burying wastes on the site, and the State informed him that a permit was required for subsurface disposal. Mr. Taylor was told to cease all dumping in November, 1977, by the Kentucky DNREP. Mr. Taylor continued his waste disposal operation and drum cleaning service until his death in late 1977. The State then directed legal actions toward Mrs. A. L. Taylor as the responsible party for her husband's business.

Also subsequent to Mr. Taylor's death, the State began to pursue the feasibility of implementing several cleanup alternatives. Initial State suggestions included: (1) onsite incineration of wastes, (2) removal and disposal of wastes at an approved Kentucky site, and (3) construction of the necessary engineering controls to allow for approved onsite disposal.

In January, 1979, representatives of the EPA first visited the A. L. Taylor site. According to the EPA report, the site contained "an estimated 20,000 drums of hazardous substances above ground and an unknown quantity of drums and liquid waste underground" (EPA, 1980b). At the time of this site visit, snow and ice covered the ground, and no direct discharge of contaminated water was seen entering Wilson Creek.

Runoff from melting snow in the spring transported oil and hazardous chemical contaminants from the site into Wilson Creek via surface runoff. On March 2, 1979, the EPA On-Scene Coordinator (OSC) was authorized to use the Federal Contingency Fund, P.L. 92-500 Section 311(k), to control runoff and eliminate further pollution of the stream. The EPA sampled the drum storage area and the Wilson Creek drainage basin and found numerous organic chemical pollutants. The final outcome of the EPA's emergency response action included the following pollution abatement measures:

- Trenches were constructed to intercept surface runoff and lateral leachate migration.
- A detention lagoon was built to receive runoff via the trenches.
- A temporary limestone/carbon treatment system was assembled to treat the contaminated runoff.
- An underflow dam was constructed across Wilson Creek downstream from the site to contain floatable material, and aerators were installed upstream from this dam to remove volatile organics.
- Surface drums were segregated and marked according to their contents (solids, liquids, empty) and organized into accessible rows.

The EPA operated and maintained the carbon treatment system until December, 1979, when the Kentucky DNREP assumed responsibility for the system.

The EPA's final count of drums located on the A. L. Taylor site after the 1979 emergency response action was 11,628 empty drums and 5,423 drums with contents. The Kentucky DNREP then addressed the problem of finding the best way to dispose of this drummed waste legally. The first step taken was to contact the waste generators who could be identified from their wastes. The following five generators were contacted: Ford

Motor Co., Reliance Universal, Inc., Louisville Varnish Co., George W. Whitesides Co., and Kurfee's Coating, Inc. These generators were asked to retrieve those drums belonging to their companies and to dispose of the wastes at an approved site. Following this removal, an estimated 4,200 drums with contents and an unknown number of empty drums remained on the site in early 1981.

When the EPA again inspected the site in the spring of 1981, drums were continuing to deteriorate and some were leaking. The temporary treatment plant installed in 1979 was receiving only minimal maintenance. The plant treatment efficiency was declining due to siltation of the process tanks and saturation of the activated carbon by organic chemicals. Furthermore, runoff from the site had deposited large volumes of silt in the detention lagoon, reducing its capacity. With the arrival of spring rainfall and snowmelt, the lagoon was near overflowing and Wilson Creek was threatened.

On September 10, 1981, the EPA Region IV OSC requested authorization to spend $100,000 to upgrade the treatment system and $300,000 for analytical work and removal of drums and liquids. The monies were provided from the Superfund emergency response fund, and on September 15, 1981, cleanup operations began under the direction of the OSC. First, vegetation was cleared from the working area. Drums were then opened, sampled, labeled as to their content, and segregated into the following categories: solids, water, solvents, solids-and-solvent, solids-and-water, unknown liquids, water-soluble oil, oil sludge, viscous drum wastes, bases, acids, and empty. Drums containing solvents were consolidated near the batching operation. Compatible solvents were mixed in a batching tank and then trucked off the site by M & M Solvent Recyclers. Drums containing contaminated water were emptied into the detention lagoon. All empty drums and drums partially filled with solids were crushed to reduce their volume.

Sludge from some of the drums and silt, sludge, and dredge material from the detention lagoon and treatment plant were spread out on a portion of the site to dry. Sawdust was then mixed with these materials to prepare them for shipment.

The runoff and leachate treatment system was upgraded at the same time. The detention lagoon was dredged and enlarged to contain a total of 2 inches of runoff from the site, and the treatment process was modified by deleting the lime treatment step and adding aeration, sedimentation, and sand filtering steps to the process. The final treatment step remained activated carbon filtration.

Cleanup operations were stopped from October 2, 1981, to November 9, 1981, while final disposal arrangements were being made for the crushed drums and the silt, sludge, and dredge materials. The Kentucky DNREP approved disposal of 114 truckloads (16,000 drums) of crushed drums at Smith's landfill in Louisville, Kentucky. Twenty truckloads of contaminated silt, sludge, and dredge material went to the Chemical Waste Management facility in Livingston, Alabama. A small amount of contaminated earth remaining on the site from the silt, sludge, and dredge material drying and loading operation was pushed into a pit left on the site by Mr. Taylor. The site received a final grading, and all equipment was cleaned and removed on November 15, 1981.

1.3 NATURE AND EXTENT OF THE PROBLEM

The paint and coatings industries of Louisville were the primary waste generators using the A. L. Taylor site. Some of the drums received at the site were dumped, cleaned, and recycled, while others were piled on the site, particularly in the later years of operation. As a result, substantial pollution of the site soils, surface water, ground water and air has occurred.

The EPA originally estimated that 20,000 drums may have been dumped or left on the site; however, the EPA compiled the following inventory of surface drums during its 1979 emergency action:

11,200	empty, crushed or piled
428	empty and recyclable
3,239	with solid contents
2,184	with liquid contents
17,051	TOTAL

By November, 1981, all of these surface drums had been removed from the site.

Substantial volumes of buried wastes remain on the site. Using electromagnetics and magnetometer surveys, TECHNOS, Inc. estimated that as much as 12,500 cubic yards of material including 18,500 drums may be located in burial areas on the site (Table 1-1 and Figure 1-2). Other less extensive burial areas may exist on the site (TECHNOS, 1981).

To substantiate TECHNOS' findings, Ecology and Environment, Inc. (E & E) performed geophysical investigations after the site was cleared of surface drums (E & E, 1982). The E & E magnetometer survey identified 66,000 square feet of area having significant anomalies. These results generally correspond to TECHNOS' findings. Based on core samples taken in 1979 by the EPA and in 1982 by E & E, the depth of contamination in soil borings taken around but not in waste cells varies from 2 to 12 feet. Assuming some vertical migration, the area under buried waste may be contaminated to a depth of 20 feet. The estimated volume of contaminated soil from buried wastes is therefore between 12,500 and 31,000 cubic yards.

The onsite open pit, which is 35 feet across and assumed to be 6 feet deep, contains an estimated 370 cubic yards of contaminated soils and waste. In addition, an open surface-dumping area covering 500 square feet still remains to the northeast of the site. This spill area measures approximately 50 by 100 feet, and the contamination is assumed to be 2 feet deep, giving an estimated volume of 370 cubic yards of contaminated soil. Therefore, the total estimated volume of contaminated soil from the buried wastes, the open pit, and the spill area ranges from approximately 13,000 to 31,700 cubic yards.

Chemical analyses of soil and water samples taken from the site indicate the presence of a wide variety of organic compounds and heavy metals. Many of the chemicals can be traced to the paint and coatings industries in the Louisville region. Sampling studies conducted in February, March, and April of 1979 measured levels of contaminants in the soil, ground water, and surface runoff (EPA, 1982). Samples were taken from ten open pit locations, 12 soil boring locations, and seven surface runoff locations, as well as the site's runoff and leachate detention lagoon (see Figure 1-3). Soil borings taken in 1982 by E & E attempted

TABLE 1-1

ESTIMATED QUANTITY OF BURIED WASTES
AT THE A. L. TAYLOR SITE
BROOKS, KENTUCKY

LOCATION	VOLUME OF MATERIAL (in cubic feet)		NUMBER OF DRUMS (uncrushed)	
	Minimum[1]	Maximum[2]	Minimum[3]	Maximum[4,5]
Trench 1	78,875	147,125	2155	8040
Trench 2	40,875	66,625	1117	3641
Trench 3	13,750	25,500	376	1393
Trench 4	38,000	63,750	1038	3484
Trench 5	21,812	36,312	596	1984
Totals	193,312	339,312	5282	18,542

NOTES:

1. Calculated using major anomaly area times 5 feet thickness plus significant anomaly area times 2 feet thickness.

2. Calculated using major anomaly area times 10 feet thickness plus significant anomaly area times 2 feet thickness.

3. Calculated using density of one drum per 36.6 cubic feet and minimum volume.

4. Calculated using density of one drum per 18.3 cubic feet and maximum volume.

5. If drums are crushed, the estimated number may increase from two to five times the number of drums given.

6. The values given are order of magnitude estimates only. Area locations are indicated in Figure 1-2. One 55-gallon drum occupies about 9.15 cubic feet. Estimates calculated assume that the drums were randomly dumped, yielding densities ranging from 18.3 to 36.6 cubic feet/drum.

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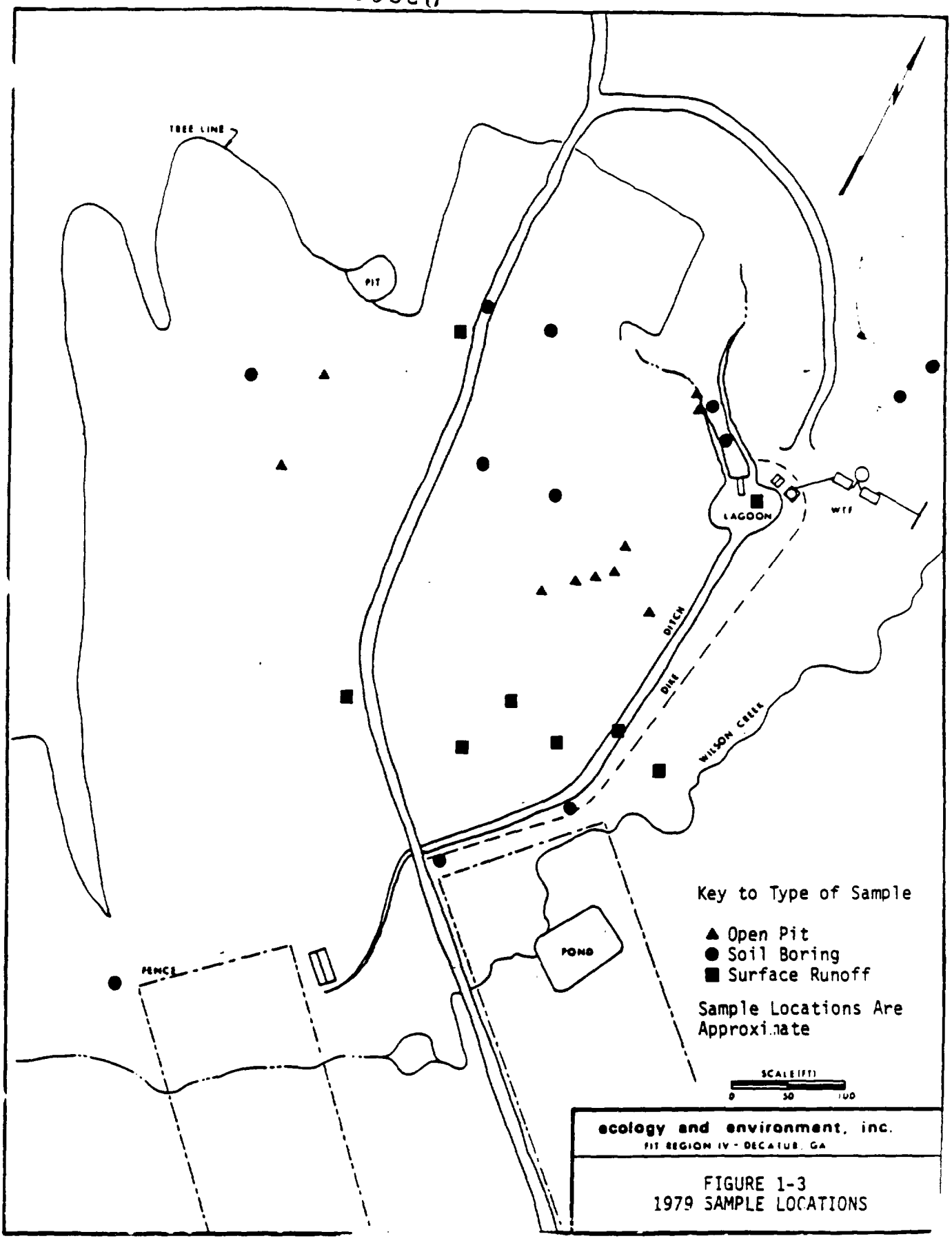

FIGURE 1-3
1979 SAMPLE LOCATIONS

to confirm this 1979 data. Although information on geophysics and soils is available, the results of chemical analyses of soil samples were not available at the time of this writing.

Potentially hazardous substances detected on the site include the following classes of chemicals: heavy metals, ketones, phthalates, polychlorinated biphenyls (PCBs), chlorinated alkanes and alkenes, aromatics, chlorinated aromatics, and polynuclear aromatics. Many of these compounds are known animal carcinogens. Many are either moderately or highly toxic to animal life when ingested or inhaled, or when they come into direct contact with the skin. Some of these compounds are cumulative poisons, such that a long-term, low-level exposure may result in injury or death. Specific examples of contaminants with long-term exposure effects found at the A. L. Taylor site are lead, chromium, antimony, methyl ethyl ketone, methyl isobutyl ketone, vinyl chloride, various PCBs, benzene, and phenol. A summary of the chemical species found on the site is presented in Table 1-2. Heavy metals have been found in concentrations in soil samples ranging from less than 15 to more than 12,000 micrograms per gram (ug/g). Priority pollutant organic compounds have been found in total concentrations ranging from less than 100 to more than 4,000 ug/g, while total organics range from 1,000 to 10,000 ug/g in soils (priority pollutants listed in the Natural Resources Defense Council, Inc., et al., Consent Decree of June 7, 1976).

Surface water pollution near the site has been severe in the past. The headwaters of Wilson Creek are located on the southern border of the site at a spring (or relic farm pond). Water, sediment, and fish tissue samples taken from Wilson Creek where it flows along the eastern border of the site have shown concentrations of heavy metals, PCBs, and organic contaminants. Solvent odors have been noted when creek sediments were disturbed. Colored stains have been observed on the creek bank and in the water, and an oily sheen has been seen on Wilson Creek (EPA, 1979a). In addition, vegetation stress has been noted on the site and along the banks of Wilson Creek.

Analysis of water and soil samples taken from test holes drilled on the site has shown contamination of the shallow ground water under the site (see Table 1-2). Most test holes drilled to the top of the underlying shale have shown the presence of small amounts of ground

TABLE 1-2

PRIORITY POLLUTANTS IDENTIFIED IN
SOIL AND WATER SAMPLES TAKEN AT THE A. L. TAYLOR SITE

PRIORITY POLLUTANT[a]	CONCENTRATION RANGES	
	Water Samples microgram/liter	Soil Samples micrograms/gram
Antimony	ND[b]	13-92
Beryllium	ND	1-3
Cadmium	ND	4-19
Chromium	10-147	1-8,212
Copper	17-970	9-12,760
Lead	16-1,890	15-292
Silver	ND	3
Thallium	11	210
Zinc	32-3,790	60-4,264
PCB-1242	3.1-7.6	.03-1.2
PCB-1248	23	.13
PCB-1254	4.2-63	.04-13
PCB-1260	4.4-71	.095-13
1,2-Benzanthracene	ND	10-78
Fluoranthene	ND	5-63
Pyrene	ND	6-70
Naphthalene	18-19	6-360
Fluorene	ND	5-19
Anthracene	ND	5-99
Acenaphthene	ND	10-450
Bis(2-Ethylhexyl)Phthalate	ND	6-2,800
Butyl Benzyl Phthalate	ND	9-25
Di-N-Octyl Phthalate	ND	7-30
Di-N-Butyl Phthalate	ND	10-55
Dimethyl Phthalate	90-1,300	ND
Diethyl Phthalate	4.9-44	ND
Pentachlorophenol	4.3	ND
Phenol	800-1,500	ND
3,3-Dichlorobenzidine	ND	33
Hexachlorobenzene	ND	5
1,2,4-Trichlorobenzene	2	ND
Benzene	9	ND
Ethyl Benzene	320-620	ND
Isophorone	370-500	ND
Toluene	400-840	ND
Vinyl Chloride	8	ND
Methylene Chloride	17-720	ND
Trans-1,2-Dichloroethylene	22-73	ND
Trichloroethylene	8	ND
Tetrachloroethylene	5-9	ND
1,1,1-Trichloroethane	9.4	ND
TOTAL ORGANIC CHEMICALS[c]	20,000-80,000	1,000-10,000

[a] Only those pollutants with quantifiable concentrations are listed. Trace amounts of other compounds may be present.
[b] ND - Not detected or below trace levels for sample size.
[c] Includes priority pollutants and other organic compounds found in site samples.

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water which is currently not used as a drinking water supply and has limited production potential. There is a concern that this contaminated shallow ground water may be hydraulically connected to Wilson Creek and thus contribute to the contamination of the surface water system. This connection may be indicated by the spring (or relic farm pond) which forms the headwaters of Wilson Creek.

In summary, past operating practices and minor accidental spills occurring during cleanup have resulted in contamination of site soils, with the depth of contamination varying across the site. Shallow contamination has resulted from surface spills and deep contamination from past dumping in trenches. An electromagnetics survey of the site has identified areas of substantial contamination (see Figure 1-2), but this survey did not define the depth of contamination. Based on these limited data, a conservative estimate of the extent of surface soil contamination would include the entire area where the soil has been disturbed and the areas where stressed or dead vegetation has been observed.

SECTION 2

PURPOSE, OBJECTIVES AND CRITERIA

The A. L. Taylor site presents the engineer with a complex problem involving a variety of contaminants and several pathways for the contaminants to affect the public health and welfare and the environment. The development of the statement of purpose, site-specific remedial response objectives and alternative evaluation criteria is an important step in the problem-solving process.

A draft of this section was submitted to the EPA and is contained in Appendix A. This original draft has been revised to be consistent with the approach used and because sufficient analytical data were not available.

2.1 STATEMENT OF PURPOSE

The purpose of the remedial response is the protection of the public health and welfare and the environment from release of contaminants located at the A. L. Taylor site. The protection provided by the remedial action is to be the most cost-effective, based on the EPA's best scientific judgement considering extent of the hazard, existing federal and Kentucky environmental quality standards and criteria, and available technologies. This purpose is consistent with Section 104 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or "Superfund Act") and the proposed National Oil and Hazardous Substances Pollution Contingency Plan. The following is a quote from Section 104 of CERCLA defining appropriate remedial actions:

> The President shall select appropriate remedial actions determined to be necessary to carry out this section which are to the extent practicable in accordance with the National Contingency Plan and which provide for the cost-effective response which provides a balance between the need for protection

of pub ıc health and welfare and the environment at the facility under consideration, and the availability of amounts from the Fund established under title II of this Act to respond to other sites which present or may present a threat to public health or welfare or the environment, taking into consideration the need for immediate action.

2.2 REMEDIAL ACTION OBJECTIVES

As discussed in Section 1, environmental samples have identified over 11ᶜ hemicals being released from the A. L. Taylor site by way of the air, ᵉe surface water, the ground water and the soil. The remedial action must therefore attenuate the environmental release of these contaminants by the application of appropriate technologies. Furthermore, the technology selected should be the most cost-effective.

The objectives must be broad in nature because of the complexity of the problem. The degree of hazard associated with each hazardous chemical release varies with the chemical type, the medium of release, and the sensitivity of the human or environmental receptors. Receptor sensitivity is ideally the factor defining the appropriate level of cleanup. Only a limited body of knowledge is available on the sensitivity of these receptors to the chemicals of concern. Considering the above, the following are the remedial action objectives for cleaning up the A. L. Taylor site:

- The air quality will be protected by the control of emissions of particulate matter, volatile organic compounds, and toxic gases.

- The surface water of Wilson Creek will be protected from leachate and runoff.

- Ground water which is suitable for domestic, agricultural or industrial water supply or contributes to the surface water will be protected from contamination.

- Casual site visitors and animals will be protected from direct contact with contaminated soils.

- Any commitment of natural resources at the A. L. Taylor site will be the most cost-effective.

2.3 EVALUATION CRITERIA

Ideally, the evaluation of remedial alternatives for abating a specific pollution source would have the following information:

- Analytical characterization identifying hazardous substances and their release rates and mechanisms.

- Quantitative criteria that allow for a determination of acceptable levels of release for each pollutant into each affected environmental component (e.g., streams, marshes, commercial fishery, residential area, etc).

- Available remedial methods of demonstrated feasibility, predictable abatement efficiencies, and known construction costs.

Based on this information, a true cost-effectiveness evaluation of remedial alternatives can be made.

In the course of the project an attempt was made to assemble the data required for such a quantitative analysis. However, significant information gaps were found for the A. L. Taylor site. As stated in Section 3, there is little analytical data that qualitatively and quantitatively characterize any present releases to surface water, ground water and air. In addition, there are several toxic pollutants at the site for which there are no federal or state regulatory criteria. Finally, hazardous waste remedial methodology is a new application of technology and lacks proven feasibility for long-term problems, thus making predictability in terms of quantitative effectiveness difficult. Because of these deficiencies, a cost-benefit analysis of the three identified remedial options presented later in this report must consist of a quantitative comparison of costs and a qualitative evaluation of

design effectiveness and feasibility based on sound professional judgement or best scientific judgement.

Life cycle costs were developed for each alternative based on estimated construction costs and operation and maintenance costs. The life cycle cost period was assumed to be 30 years to be consistent with the closure policy of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act of 1976, as amended. Twelve percent annual interest was assumed to estimate the cost of financing each alternative. Labor, material, and utility costs were assumed to escalate 10 percent per year. The costs of all alternatives were ranked, with preference given to the least expensive remedial response alternative.

In addition to cost analysis, the effectiveness evaluation consists of subjectively assessing each remedial option in terms of its mitigating effect on each known or suspected active release mechanism, i.e., surface and ground water movement, airborne release, and direct contact with site contaminants. For air and ground water there is no analytical evidence of current release and only sparse or obsolete data to characterize surface water and direct contact exposure levels. This lack of exposure information and the large variety of chemical pollutants known to be present in site soils make it difficult to assess the environmental risks posed by the A. L. Taylor site. Therefore, the "effectiveness" element of the cost-effectiveness analysis is not quantitative but is based on acceptable and reasonable engineering solutions to abate known or suspected releases.

The qualitative criteria used to assess the remedial options are:

- **Reliability**: This considers the extent to which a system, device, or technology will perform a desired function correctly for a number of repeated trials or for an extended period of time. Without test data measuring performance against an established standard, reliability of each alternative was a scientific judgement. The alternatives were ranked as to their relative reliability without attempting to establish the quantitative reliability of each alternative.

- Implementability: This is the physical, mental, financial and legal power to carry out the alternative. Because of the varied nature of the possible remedial alternatives, they were ranked based on their ease of implementation. Consideration was given to public opinion, regulatory procedures, duration, scheduling natural constraints (such as weather), and technical feasibility. The most easily implemented alternative was preferred.

- RCRA Conformance: Each alternative design was compared to new landfill design standards permitted under the Resource Conservation and Recovery Act (RCRA). The alternative which provided environmental protection performance similar or superior to a RCRA-permitted landfill was given preference.

- Environmental Concerns: These were identified for each alternative, and the alternative with the least adverse environmental impact received preference.

- Safety Requirements: These were developed to mitigate the risks of construction of each alternative. Where necessary, risk assessments were made on each operation. The safety requirements and relative risk of each alternative were compared and the alternatives ranked. Preference was given to the alternative having the lowest relative risk and least safety requirements.

- Operation and Maintenance Efforts: Manpower and equipment requirements were identified for each alternative for a 30-year project period. Maintenance effort was based on parts replacement, corrosion control and safety requirements when applicable. Operation personnel, utility costs, and major system replacement requirements for each alternative were developed. When comparing alternatives, those with the least long-term commitment of capital, manpower and equipment were preferred.

SECTION 3

ENVIRONMENTAL SETTING

A current description of the environmental setting of the A. L. Taylor site and vicinity establishes a baseline from which the environmental assessment of each alternative will be compared. The A. L. Taylor site is an abandoned 23-acre dump used for disposal of municipal trash and waste industrial chemicals. The site is located in a valley in north-central Bullitt County, Kentucky, just south of the Jefferson County line between the Louisville and Nashville Golf Course and Kentucky Highway 1020 (see Figure 1-1). The study area for the environmental setting is within a 1-mile radius of the site (Figure 3-1). EPA emergency cleanup actions have removed all above-ground waste from the site; however, substantial quantities of hazardous wastes are still buried or mixed with the surface soils. The natural conditions of the site soils, vegetation and topography have been significantly changed as a consequence of past activities.

3.1 TOPOGRAPHY

The topography of the north-central portion of Bullitt County is characterized by steep slopes, particularly in that portion of the county bordering Jefferson County. The A. L. Taylor site falls within this general characterization, having as a most striking feature an estimated 20 to 30 percent slope on the western and northern sides of the site. These sharp slopes, which are the result of excavating the sides of adjacent hills, are currently unvegetated and eroding rapidly. The northeastern edge of the site is bordered by another hill with a slope of approximately 12 percent, while the southern portion of the site has moderate relief with a consistent slope of approximately 7 percent. Most of the surface area at the site has been graded or in some way physically altered so that the land gradually slopes eastward toward Wilson Creek. The southwestern third of the site drains towards the southeast along

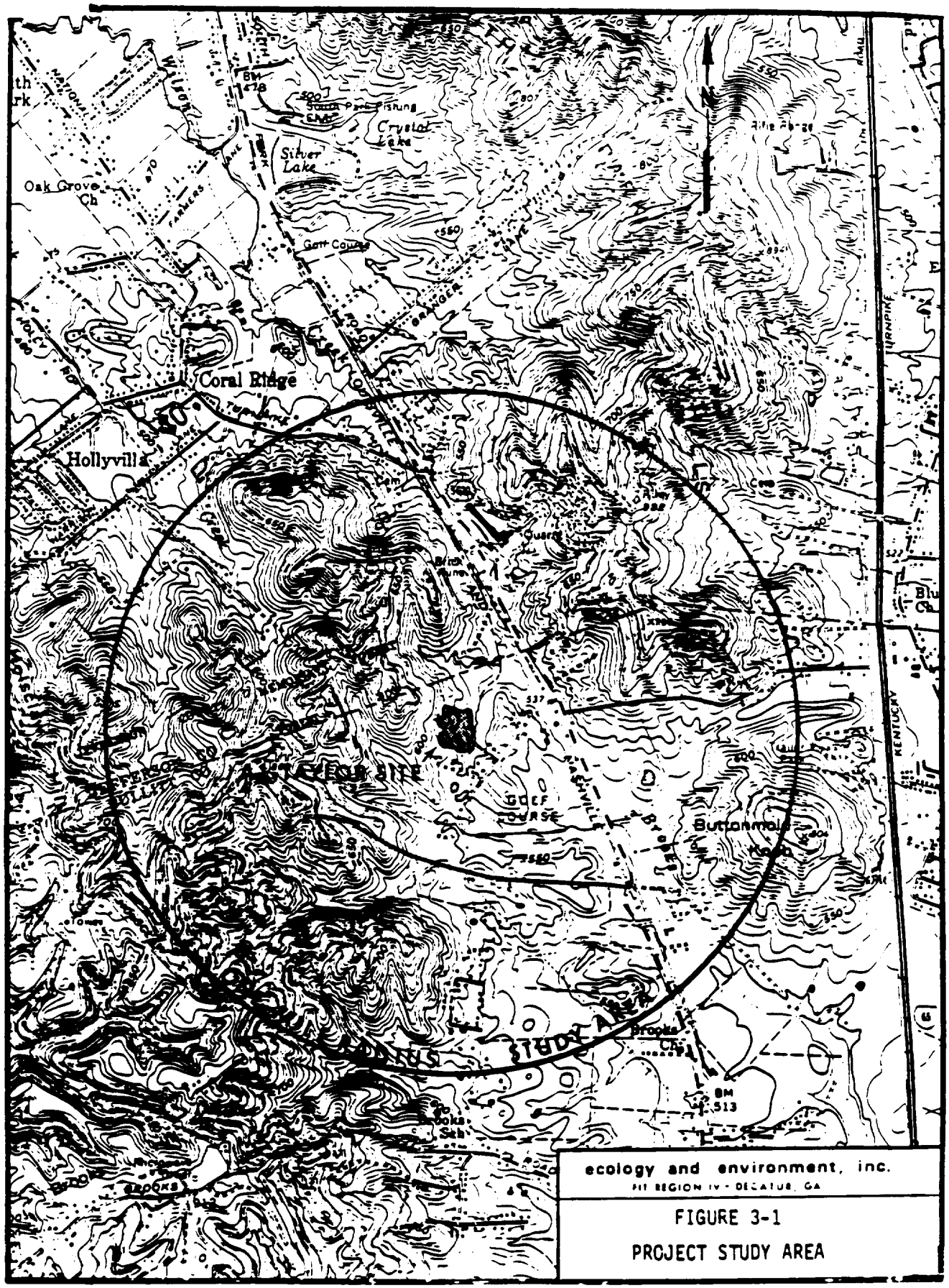

FIGURE 3-1

PROJECT STUDY AREA

established erosion patterns. Runoff from this area spreads out into sheet flow and eventually joins Wilson Creek.

3.2 SOILS

The upper slopes of the site are characterized by soils of the Litz-Muskingum series, which are silt loams found on slopes of 20 to 30 percent gradient. These are excessively drained, shallow soils formed in residuum derived from siltstone, shale, and sandstone.

Soils of the lower valley slopes and the valley bottom are of the Zanesville series, which are characteristic of the Knobs region. Zanesville soils are silt loams formed from loess and residuum derived from sandstone and shale. Slopes range from 2 to 6 percent to 12 to 20 percent. These soils are moderately well drained, but vertical movement of ground water may be restricted by the fragipan found in the lower Zanesville soils (Zimmerman, 1966).

Surface soils in the site area used for waste disposal have been significantly altered by excavation and grading during operation and emergency cleanup. As a result, there is little topsoil remaining. The uppermost soil layer consists of 1 to 5 feet of silty clay, underlain by 2 to 8 feet of gray-green clay, then by 1 to 5 feet of weathered shale above the unweathered shale (see Section 4.2.1).

3.3 GEOLOGY

The A. L. Taylor site is in the Knobs physiographic region, which is a series of erosional remnants formed of Mississippian and Pennsylvanian rocks overlying Silurian and Devonian rocks. Mississippian rocks are limestones and siltstones with some shale beds, while Pennsylvanian rocks are sandy limestones and sandstones which form the cap rocks in the Knobs (Hopkins, 1966).

The Knobs province is on the western edge of the Jessamine Dome, a structural dome which lies along the axis of the Cincinnati Arch. Regional dip of the formations in the vicinity of the site is gentle at 2 to 4 degrees to the southwest.

The site is underlain, in stratigraphic order (top to bottom), by the New Providence Shale, the New Albany Shale, the Louisville Limestone,

and the Waldron Shale (Table 3-1). The New Providence Shale begins as shallow as 3 feet and is weathered to a depth of 12 to 13 feet. Joints and fractures in the New Providence Shale are numerous and are 2 to 5 feet long. It is not known at this time how open the fractures are, how continuous they are, or if there is significant intersecting of openings.

3.4 GROUND WATER

3.4.1 Aquifer Description

Ground water at the site occurs in two aquifers: a shallow unconfined residual soil aquifer and a deeper confined consolidated rock aquifer. The shallow aquifer varies in thickness from approximately 3 to 25 feet. Water levels from hand-augered wells in this aquifer range from 2.4 to 6.4 feet below land surface. Based on topography, shallow bedrock, and water levels in wells, the direction of ground water flow in the shallow aquifer is from the hills southeasterly toward the valley of Wilson Creek. The rate of ground water movement is slow, 0.01 to 0.1 feet per year.

Shales, which comprise the uppermost geologic formations in the site area, are relatively impermeable and thus retard the downward movement of water. However, water may move locally into a lower formation through openings developed by faulting, by intersecting joint systems, or by solution where the shale formation is thin or calcareous. In the Knobs area, the small number of sink holes and low-yielding springs indicates that the subsurface drainage system is poorly developed (Hopkins, 1966).

The deep aquifer occurs in the limestones under the confining shale formations. The Louisville Limestone of Silurian age, along with the Jeffersonville and Sellersburg Limestone, forms a single confined aquifer of secondary importance that yields most of the water pumped from consolidated rocks in this area of the state. Water is contained in and moves along interconnected fractures and solution channels (Bell, 1966).

Locally, little use is made of the shallow or deep aquifers, and no nearby wells that penetrate the deep aquifer are known to be in use. (One unused well that penetrates the shale is 600 feet southeast of the site.) No water level records on deep aquifer wells in Bullitt County

TABLE 3-1

GENERALIZED STRATIGRAPHY AND WATER BEARING CHARACTERISTICS
OF GEOLOGIC UNITS IN VICINITY OF A. L. TAYLOR SITE

SYSTEM	SERIES	GEOLOGIC UNIT	DOMINANT LITHOLOGY	WATER-BEARING CHARACTERISTICS
Mississippian	Lower Mississippian	New Providence Shale	Shale, greenish-gray, ferruginous, calcareous concretions and lenses, with ferruginous limestone patches and lenses. Fine-grained sandstone layers with interbedded shale at top. 90 ft. thick	Yields 0.07 to 0.35 gpm[a] to wells in valley bottoms; may yield more than 0.21 gpm[a] where thick siltstone beds occur at or below stream level; yields almost no water to small springs in limestone and siltstone.
Devonian	Upper Devonian	New Albany Shale	Shale, black fissile slightly calcareous, carbonaceous with pyrite scattered throughout and in a layer at the base. Contains thin sandstone and shale layers. 60 ft. thick	Yields 0.07 to 0.35 gpm to shallow drilled wells in broad, flat areas, but almost no water to drilled wells on hillsides; yields water to small springs and dug wells.
Silurian	Middle Silurian	Louisville Limestone	Limestone, thick-bedded fine-grained, magnesian or siliceous in part. 130 ft. thick	Yields more than 0.35 gpm to wells drilled in valley bottom or along streams in broad uplands; yields as much as 50 gpm in places; yields water to springs at contact with underlying Waldron Shale.
		Waldron Shale	Shale, green-gray non-fissile calcareous, magnesian, siliceous.	Yields almost no water to wells or springs. Basal confining layer of Louisville Limestone.

Modified from Palmquist and Hall, 1960.

Note: [a] gpm = gallons per minute

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are available; however, in adjacent Jefferson County, records from wells penetrating the aquifer show water levels averaging about 34 feet below land surface at the well.

Vertical ground-water flow direction has not been defined; flow is related to the interconnection of fractures or joints within the rocks and the hydraulic gradient. Although movement of ground water from the shallow aquifer to the deep aquifer cannot be precluded, it is unlikely.

3.4.2 Ground Water Quality

No background data are available on the quality of natural ground water from the shallow residual soil aquifer. Since the soil is derived primarily from shales, the water is probably soft to slightly hard and may contain sulfate or iron in significant quantities. The water may be suitable for domestic use after treatment.

Water from the underlying limestone formations (the deep aquifer) is hard and may be highly mineralized. In the Knobs area, saline water with high concentrations of chlorides, sulfate, iron, and manganese interfaces with fresh water between 65 and 165 feet below land surface. Water above the interface ranges from calcium bicarbonate type to a sodium bicarbonate type; below the interface, water is a sodium bicarbonate or sodium chloride type (Hopkins, 1966).

The quality of water from consolidated rocks at the A. L. Taylor site is not known. Data from wells elsewhere is the county indicate that the quality varies. In some areas salinity is low enough that the water is suitable for some purposes such as agriculture, while in other areas the water is too saline for any use.

3.5 SURFACE WATER

3.5.1 Stream Description

The A. L. Taylor site is located in the Salt River drainage basin. Wilson Creek, which drains the site, is a small tributary originating from a spring (or relic farm pond) south of the site. The creek initially flows northward, joining first Southern Ditch and then Pond Creek, which flows into the Salt River just above the Salt River's

confluence with the Ohio River. The Ohio River is a source of public drinking water for some communities downstream from the Salt River confluence (KIPDA, 1978). Substantial dilution of Wilson Creek water would occur before the first public water supply is encountered. The flow rate of the Ohio River at Louisville is 114,000 cubic feet per second (cfs) (Bell, 1966), while the flow rate of Wilson Creek is about 0.1 cfs. The dilution factor is thus about 1,000,000 to 1.

Average precipitation for the State of Kentucky is 69 inches per year (USGS, 1979), and the climate is moist and temperate. High intensity rainfalls of more than 4 inches per hour occur annually. The flow cycle of streams in the area is one of rapid, heavy discharge after a heavy or moderate rainfall leading to stream-cleansing actions such as dilution, flushing and streambed scouring.

The normal stream flow of Wilson Creek is low and subject to fluctuation from seasonal storm and snowmelt water contribution. The stream bottom in the upper reaches consists of sand and clay deposits, which are erosional products from adjacent upland areas, as well as some weathered bedrock. Since Wilson Creek does not have a U.S. Geological Survey (USGS) gaging station, there are no historical stream flow data (Nadeau, 1979).

3.5.2 Surface Water Quality

The USGS and EPA have identified surface water quality problems in the Pond Creek system due to poorly treated wastewater discharge. Surface waters are generally suitable for public water supplies and industrial uses when properly treated (USGS, 1979; KIPDA, 1978, Vol. 5).

Water from a tributary of Wilson Creek was sampled and analyzed by the EPA in March, 1979 (Nadeau, 1979). A few organic compounds in low concentrations were found in the sample, but the concentrations were lower than those from onsite surface water samples. Another control sample from Wilson Creek upstream from the site was analyzed for standard water quality parameters (see Table 3-2). The analysis indicated that Wilson Creek water contains mineral constituents similar to streams

TABLE 3-2

SURFACE WATER QUALITY OF
WILSON CREEK UPSTREAM
FROM A. L. TAYLOR SITE
(BASED ON ONE GRAB SAMPLE)

MAJOR CONSTITUENT	CONCENTRATIONS (milligrams/liter)
Silica	-
Calcium	11
Magnesium	5
Aluminum	3.1
Iron	5
Manganese	1.3
Sodium	5

Source: Nadeau, 1979

elsewhere in the area. Based on one grab sample, the control sample water appears to conform to EPA drinking water standards.

3.6 TERRESTRIAL BIOLOGY

3.6.1 Vegetation

The A. L. Taylor site is located among the forested Knobs of southern Jefferson and north-central Bullitt Counties. Several tracts of forest land in southern Jefferson County comprise the Jefferson County Memorial Forest, which consists of over 1,500 managed acres in the Knobs region. The vegetation in this managed area is characterized as a typical second-growth forest with the dominant overstory species being Virginia pine, some white and red oaks, and maples. Dogwoods and sourwoods, along with shrubs such as spice bush, are also present in the Memorial Forest. Although an actual inventory of the tree community for the area immediately surrounding the A. L. Taylor site is not available, the vegetation is expected to be similar to that described above. The site is located on the periphery of the Knobs region, and the valley hillside habitats are suitable for the same hardwoods and pines. The southern border of the site is adjacent to an open field formerly used for farmland, while to the southeast there is a 145-acre, privately owned golf course and picnic area. The eastern border of the site is formed by Wilson Creek and is vegetated with typical bottomland hardwoods and pines. Shrubs are more abundant in this low-lying area and form a dense understory.

3.6.2 Wildlife

About 50 species of mammals are known to exist in the north-central region of Kentucky (Appendix B). However, due to area development and limited habitat diversity, it is doubtful that some of these animals, such as beavers or otters, are present in the immediate vicinity of the Taylor site. No field survey has been performed to identify the species which inhabit the project area.

Furbearers typically inhabiting the forested Knobs include raccoons, weasels, mink, muskrats, opossums and woodchucks. The white-tailed deer is the only big game animal occurring in this region of Kentucky. The

eastern cottontail rabbit and gray squirrel are some of the small game species anticipated to occur in the project area. Gray fox, red fox and possibly coyotes represent the predator mammals found in this region. Other typical mammals residing in the area include the striped skunk, eastern chipmunk, eastern mole, fox squirrel, and several species of bats, mice, voles and shrews.

Approximately 34 species of amphibians and 40 species of reptiles reside in this portion of Kentucky (Appendix B). Amphibians commonly found in local streams, ponds, puddles and moist terrestrial environments include the eastern newt, mudpuppy, Jefferson salamander, two-lined salamander, slimy salamander, red salamander, bullfrog, pickerel frog, American toad, spring peeper and chorus frog. Local reptiles include the snapping turtle, pond slider, box turtle, smooth softshell turtle, fence lizard, five-lined skink, black racer, ringnecked snake, rat snake, hognose snake, kingsnake, milksnake, northern natri (water snake), green snake, queen snake, garter snake and copperhead.

3.6.3 Birds

Approximately 264 avian species have been sighted in north-central Kentucky in recent years (Appendix B). About 144 of these species reside here permanently or seasonally, and an estimated 120 species are transients.

Resident non-game birds include the turkey vulture, red-tailed hawk, American kestrel, killdeer, herring gull, yellow-billed cuckoo, screech owl, horned owl, chimney swift, common flicker, red-bellied woodpecker, downy woodpecker, eastern kingbird, crested flycatcher, wood wewee, barn swallow, purple martin, bluejay, tufted titmouse, Carolina wren, mockingbird, catbird, brown thrasher, woodthrush, red-eyed grackle, summer tanager, cardinal, goldfinch, rufus-sided towhee, dark-eyed junko and several species of sparrows.

A number of waterfowl and/or game species thrive in this portion of the state. Canada geese, mallards, black duck, gadwall, wigeon, wood duck, ring-necked duck, canvasback and hooded merganser are are characteristic residents of area streams and lakes. Important terrestrial game species include dove, quail and grouse. Turkeys have

also been introduced in Bullitt County and an established breeding population now exists. No field survey has been performed to confirm the absence or presence of bird or waterfowl species in the project area.

3.7 AQUATIC BIOLOGY

3.7.1 Aquatic Invertebrates

Amphipods and isopods were dominant in benthic samples taken from streams adjacent to the A. L. Taylor site, according to an EPA summary report (KDNREP, 1979). These streams consisted of Wilson Creek and an unnamed branch of Wilson Creek. This report also stated that numerous crayfish were collected by State of Kentucky officials in a similar study. A total of nine taxa were indicated by the EPA investigation (Appendix B) including Gammarus sp., Lirceus sp., Cambarus sp., Physa sp., Tipula sp., Turbellaridae sp., Ephemeroptera sp., Limnephilidae sp., and Trichoptera sp. According to this study many of these organisms are tolerant to human disturbances.

3.7.2 Fish

Wilson Creek was sampled under the direction of the Kentucky Division of Water Quality in March, 1979. Fishes reported from this study are typical of central Kentucky tributaries and are listed in Table 3-3 (KDNREP, 1979). Cyprinids (minnows and suckers) comprised the largest portion of species and individuals collected. Several of these species are quite abundant in the state and are somewhat tolerant of man-induced disturbances: creek chub, bluntnose minnow, fathead minnow, emerald shiner, stoneroller, carpsucker and small mouth buffalo. Appendix B presents a list of typical species for north-central Kentucky.

The Kentucky sampling study identified only one darter, the johnny darter, in Wilson Creek. Darters are common in riffle habitats of the Mississippi drainage, and the lack of darters indicated by this study may be attributed to degradation of the water quality or the habitat in which these sensitive organisms exist.

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TABLE 3-3

FISHES OCCURRING IN THE VICINITY OF THE A. L. TAYLOR SITE (1979)

FAMILY	SCIENTIFIC NAME	COMMON NAME	NUMBER COLLECTED
	Wilson Creek (Mile 2.8)		
Cyprinidae	Phoxinus erythrogaster	Red belly Dace	1
	Campostoma anomalum	Stoneroller	1
	Pimpephales notatus	Bluntnose minnow	6
	Semotilus notatus	Creek Chub	26
Percidae	Etheostoma nigrum	Johnny darter	2
	Wilson Creek (Mile 1.2 - 1.3)		
Catostomidae	Catostomus commersoni	White sucker	6
Esocidae	Esox americanus	Grass pickerel	1
Cyprinidae	Semotilus atromaculatus	Creek chub	61
	Phoxinus erythrogaster	Redbelly dace	1
	Pimpephales notatus	Bluntnose minnow	7
	Pimephales promelas	Fathead minnow	1
Ictaluridae	Ictalurus melas	Black bullhead	1
Centrarchidae	Lepomis cyanellus	Green sunfish	9
	Lepomis macrochirus	Bluegill	4
	Southern Ditch (Mile .6 - 1.0)		
Cyprinidae	Pimeplales promelas	Fathead minnow	5
Centrarchidae	Lepomis cyanellus	Green sunfish	9
	Lepomis macrochirus	Bluegill sunfish	1
	Pond Creek (Mile 7.8 - 7.9)		
Cyprinidae	Pimephales promelas	Fathead minnow	2
	Carassius auratus	Goldfish	2
	Notropis atherinoides	Emerald shiner	28
Ictaluridae	Ictalurus melas	Black bullhead	2
Poeciliidae	Gambusia affinis	Mosquitofish	2
Centrachidae	Lepomis macrochirus	Bluegill	7
	Lepomis cyanellus	Green sunfish	23

Source: KDNREP, 1979

3.8 THREATENED AND ENDANGERED SPECIES

3.8.1 Federally Protected Species

A list of the federally protected threatened and endangered animal species that may occur in the project area is presented in Table 3-4. The designated critical habitats for the Indiana bat in Kentucky are in Carter and Edmondson Counties (FWS, 1981). Kentucky's Indiana bat population was estimated to be 56,000 in 1975, a 73 percent decline since 1955 (Stephens, 1979). A maternity colony of the Indiana bat has been identified as using a reach of Knob Creek in northwest Bullitt County during the summer of 1979 (Kessler, 1980). The gray bat, considered endangered in the entire state, primarily inhabits central Kentucky. The eastern cougar is considered extinct in Kentucky, although occasionally there are rumors of possible sightings. Two of the federally protected birds, the arctic peregrine falcon and the bald eagle, are occasionally reported in this region of Kentucky. The bald eagle has been seen as a winter visitor on western Kentucky lakes and streams (Stephens, 1979). There are no fish, amphibians, reptiles or plants in Kentucky currently listed by the U.S. Fish and Wildlife Service as threatened or endangered.

3.8.2 Species of Special Concern

The State of Kentucky has developed a list of rare species occurring in Kentucky that may be common in other parts of their range. These plant and animal species are not officially protected through the State's Endangered Species Regulation, although in some instances the wildlife is protected by restricting the hunting seasons. One such species is Bachman's shrew, which is known to live in wet habitats in western Kentucky, reaching north to Bullitt County, where the A. L. Taylor site is located. Other mammals possibly found in this region are the spotted skunk, meadow jumping mouse, Virginia (western) big-eared bat and river otter. The rare amphibians and reptiles that may occur in the project area include the corn snake, eastern ribbon snake and four-toed salamander. The troutperch lives in the Salt River drainage basin in Jefferson County and prefers deep pools and sandy bottoms in slow-moving streams (Stephens, 1979). According to the Kentuckiana Planning and Development Agency (KIPDA) 208 study, the habitat requirements of an annual plant of the mustard family, Leavenworthia exigua var. laciniata,

TABLE 3-4

FEDERALLY LISTED THREATENED AND ENDANGERED ANIMAL SPECIES
THAT MAY OCCUR IN PROJECT AREA

SCIENTIFIC NAME	COMMON NAME
Mammals	
Myotis grisescens	Gray Bat
Myotis sodalis	Indiana Bat
Felis concolor cougar	Eastern Cougar
Birds	
Haliaeetus leucocephalus	Bald Eagle
Falco peregrinus anatum	American Peregrine Falcon
Falco peregrinus tundrius	Arctic Peregrine Falcon
Vermivora bachmanii	Bachman's Warbler
Campephilus principalis	Ivory-billed Woodpecker

Source: FWS, 1982

are found in the north-central portion of Bullitt County (KIPDA, 1978). These plant and animal species have not been identified in the immediate vicinity of the A. L. Taylor site, but it is possible that their habitat requirements may be found in the project area.

3.9 SOCIOECONOMICS

Bullitt County has experienced rapid growth since the 1950's, partly because of the construction of Interstate 65. Much of Bullitt County serves as suburbs of Louisville, particularly with increased competition in the Louisville land and housing markets. Bullitt County's accessibility to Louisville is also enhanced by the National Turnpike (Kentucky Highway 1020), Preston Highway (Kentucky Highway 61), Kentucky Highway 44 and Bardstown Road (U.S. Route 31E). The population centers in the northern section of this county include Shepherdsville (pop. 4,454), Mt. Washington (pop. 3,997), and Hillview (pop. 5,196) (Schoenbaechler, 1982). The population of Bullitt County is expected to double between 1975 and 1995, increasing from 32,785 to 70,582 (KIPDA, 1978, Vol. 2). According to the 1980 Census, Bullitt County had a total population of 43,346 (Schoenbaechler, 1982).

The area surrounding the A. L. Taylor site is largely undevelopable land. The tract of land along the National Turnpike is limited in linear development because of topographic features. Nevertheless, the number of residents in this area is expected to continue to increase slightly, due to its accessibility to Louisville. Because of this and the lack of suitable land, the area around the site is expected to be saturated with housing by 1995. However, the topographic restrictions will keep the population density in this area below the average expected for Bullitt County (KIPDA, 1978, Vol. 2).

The per capita income for residents of Bullitt County has fluctuated since 1967. According to the 1978 KIPDA 208 Study, the 1975 real dollar per capita income for Bullitt County was $3,317. In the areas surrounding the A. L. Taylor site, the 1975 per capita income was less than the county average. Projections of the 1995 per capita income for Bullitt County reflect an annual growth rate that exceeds the national

and State of Kentucky projected annual averages for the same year (KIPDA, 1978, Vol. 2).

Employment in Bullitt County has not increased in proportion to the population growth. The majority of the labor force commutes out of the county for work, in particular traveling north to Jefferson County. County employment is expected to increase by 1995 as the local markets improve economically and as employment opportunities begin to diversify. The industrial sector of Bullitt County is dominated by one firm in Clermont and another in Shepherdsville. In 1975, these two employers accounted for 80 percent of the county's total industrial employment. The manufacturing and mining sectors of Bullitt County involved about 8 percent of the total industrial workers. The projected target area for most of the county's industrial growth is between the Louisville and Nashville Railroad and Interstate 65 (KIPDA, 1978, Vol. 2).

3.10 LAND USE

Over 90 percent of the land along the north-central border of Bullitt County is classified as being used for agriculture or otherwise vacant. The next largest land use category is single-family residential, which accounts for roughly 10 percent of the total acreage in north-central Bullitt County (Schoenbaechler, 1982). As Figure 3-2 shows, the land use patterns in the project area follow the same trend with forested and agricultural land use dominating.

The area of most development within 1 mile of the A. L. Taylor site is to the south and east. Single-family homes are located along Letts Road, which runs along the southern border of the site. The community of Brooks is about 1.5 miles southeast of the site. Single-family homes located on roads branching from Brooks Hill Road also fall within a 1-mile radius of the site. A trailer park, a more concentrated residential area, is located about 3,500 feet east of the site adjacent to Interstate 65. A quarry representing the only small industry in the project area is northeast of the site along National Turnpike. A privately owned recreational area is found south of the site.

The A. L. Taylor site itself is a 23-acre plot, 13 acres of which have been disturbed for disposal of chemical wastes. The site has been

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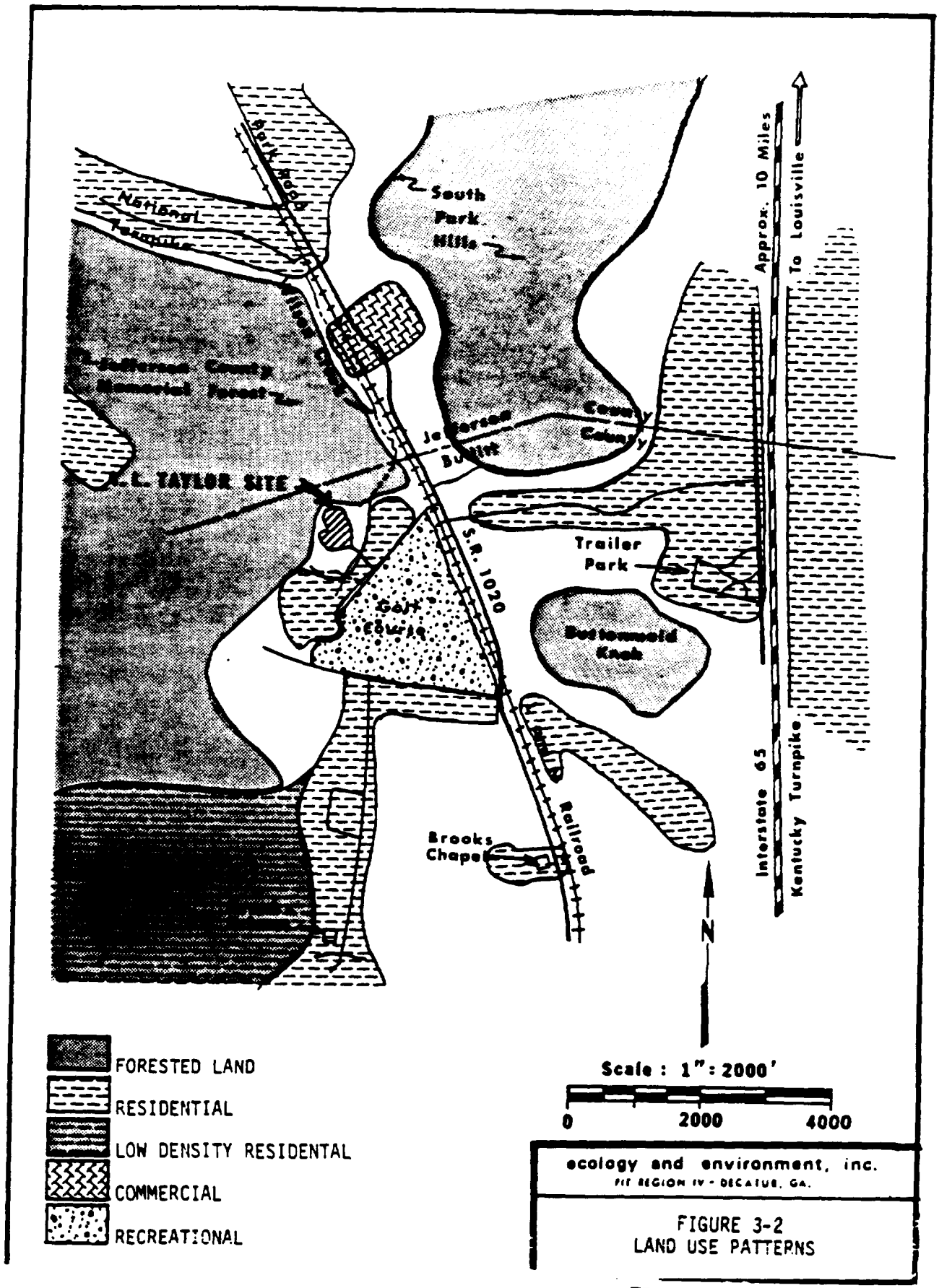

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FIGURE 3-2
LAND USE PATTERNS

partially cleared on several occasions, the most recent being between September and November, 1981.

3.11 AIR QUALITY

Because of the nature of the A. L. Taylor site and the anticipated remedial action, only particulate matter, hydrocarbons and toxic gases are of interest to air quality. The only particulate matter monitoring station in Bullitt County is located in Shepherdsville at the municipal water plant, slightly over 5 miles south of the site. The primary ambient air quality standard for particulate matter was attained at Shepherdsville; however, two daily concentrations exceeded the secondary standard in 1980: 160 micrograms per cubic meter (ug/m^3) and 154 ug/m^3 (standard is 150 ug/m^3). The 1980 annual average for particulate matter was 69 ug/m^3 (KDNREP, 1980). These monitoring results indicate that Bullitt County has reasonably good air quality in terms of particulate matter.

Ozone is monitored as an indicator of the level of oxidants in the atmosphere. The Shepherdsville ozone monitoring station is located at the Roby Elementary School just over 5 miles from the A. L. Taylor site. Data collected at this monitoring station exceeded the primary standard of 0.12 parts per million three times during the year. Numerous violations of the ozone standard also occurred north of the site in the Louisville area during 1980 (KDNREP, 1980). These violations indicate the need for controlling hydrocarbon emissions at the site because hydrocarbons are the recognized precursors to photochemical oxidants.

No onsite air quality monitoring has been performed at the A. L. Taylor site. As a result, there are no data on any toxic gases that the wastes may be releasing to the atmosphere.

SECTION 4

GEOHYDROLOGIC STUDIES

Geohydrologic studies have been conducted at the site to locate subsurface features that might identify zones of buried drums and liquid wastes, and plumes of migrating contaminants. Additionally, these studies can provide information on natural geological and hydrological features such as depth to bedrock, locations of major geologic fractures and location of ground water. This information is needed to support remedial design. Two separate geophysical studies have been performed at the A. L. Taylor site, one by TECHNOS, Inc., and a more recent study by E & E's Region IV Field Investigation Team (FIT). The E & E study is not complete at this time.

4.1 TECHNOS STUDY

In the spring of 1981, TECHNOS, Inc. conducted geophysical studies using electromagnetics, magnetometer readings, metal detection, resistivity measurements, and seismic methods (TECHNOS, 1981). The objectives of this study were to determine the location and extent of buried metal drums, waste dump pits, and leachate plumes to support a previous feasibility analysis of constructing a land disposal cell on site.

TECHNOS located five major burial areas on the site with associated contamination plumes, but found no evidence to indicate the presence of fractures in the shale at the site. Resistivity soundings indicated that a 60-foot thickness of New Providence Shale underlies the site. The New Providence Shale is underlain by the New Albany Shale. The top of the unweathered shale surface was estimated to be 12 to 30 feet below land surface. TECHNOS reported "no evidence of fractures or stratigraphic anomalies" in the shale.

At the time the TECHNOS study was done, about 4,000 drums containing hazardous waste material were on the site. Although the drums were stacked in rows, they still impeded thorough coverage during the

geophysical survey. The presence of these drums may have also distorted the boundaries of subsurface anomalies delineated by the survey. The surface drums have since been removed and the site graded.

4.2 E & E STUDY

The purpose of the E & E investigation was to establish engineering criteria for cleanup alternatives by more closely defining the geohydrologic characteristics of the site and the location of drum burial sites and subsurface contamination zones (E & E, 1982). Also, information was sought to determine elevations of the ground-water table, direction and rate of ground-water flow, and the presence of subsurface fractures which may affect movement of contamination plumes.

The geohydrologic studies performed by E & E in December, 1981, and January, 1982, consisted of four elements: (1) a geologic survey of the immediate area, (2) a limited topographic survey of the site, (3) geophysical surveys consisting of resistivity soundings and magnetometer traverses, and (4) a drilling program which included installation of 17 drilled auger holes.

4.2.1 Geologic Survey Results

The New Providence Shale of Lower Mississippian age is exposed at the northwest boundary of the site. The shale at this outcrop is extensively fractured and jointed, probably due to weathering effects and unloading of overburden. The shale at the outcrop strikes north 40 degrees east and dips 14 degrees to the southeast. This orientation of the shale beds indicates that ground water at the site probably flows in a southeasterly direction. The amount of dip may be slightly exaggerated due to slumping of the material on the hillside where the shale is exposed. The upper section of the shale outcrop contains numerous ironstone concretions or nodules ranging in diameter from 1 inch to more than 1 foot. The shale is deeply weathered in most locations at the site and forms a series of low, nearly parallel east-west-trending ridges. Shallow valleys between the ridges may indicate the presence of joint systems or fracture zones. No other rock outcrops occur in the vicinity of the site.

4.2.2 Topographic Survey Results

The entire A. L. Taylor site was gridded on 50-foot spacings. North-south lines were given letter coordinates and east-west lines number coordinates. Resistivity soundings and drill holes are referenced according to their locations on the grid. Each node on the grid was surveyed using a U.S. Geological Survey reference elevation. A topographic map of the site constructed from elevations measured by this survey is shown in Figure 4-1. Elevations at the site range from 533.2 to 576.1 feet above mean sea level, for a total relief of 43 feet. Slopes average 7 percent.

4.2.3 Geophysical Survey Results

Resistivity

An electrical resistivity survey is a method for shallow subsurface exploration by means of electrical measurements taken at the surface of the earth. The method is based on the fact that some earth materials are better resistors of electrical current than others. Resistivity, the opposite of conductivity, is proportional to a material's content of water or moisture and dissolved salts or free ions (Bison Instruments, 1975). Therefore, the method can help determine the presence of saturated zones, water-bearing fractures, major changes in rock type, or change in water from fresh to saline. The primary constraint is the need for verification by drilling boreholes to the depth of the soundings.

Sixteen resistivity soundings were made at the site: fourteen 100-foot soundings, one 30-foot, and one 300-foot. Verification of the shallow part of the soundings was obtained from installation of boreholes drilled to the top of bedrock. Interpretations of resistivity soundings are based on correlations with these boreholes and on known geohydrology of the area from the literature. Locations of the soundings are given in Figure 4-2. Although results are interpretive and made without deep borehole field testing, the following features are suggested:

- Soil ranges from 15 to 25 feet thick (in most places 20 feet) and is mostly clay.

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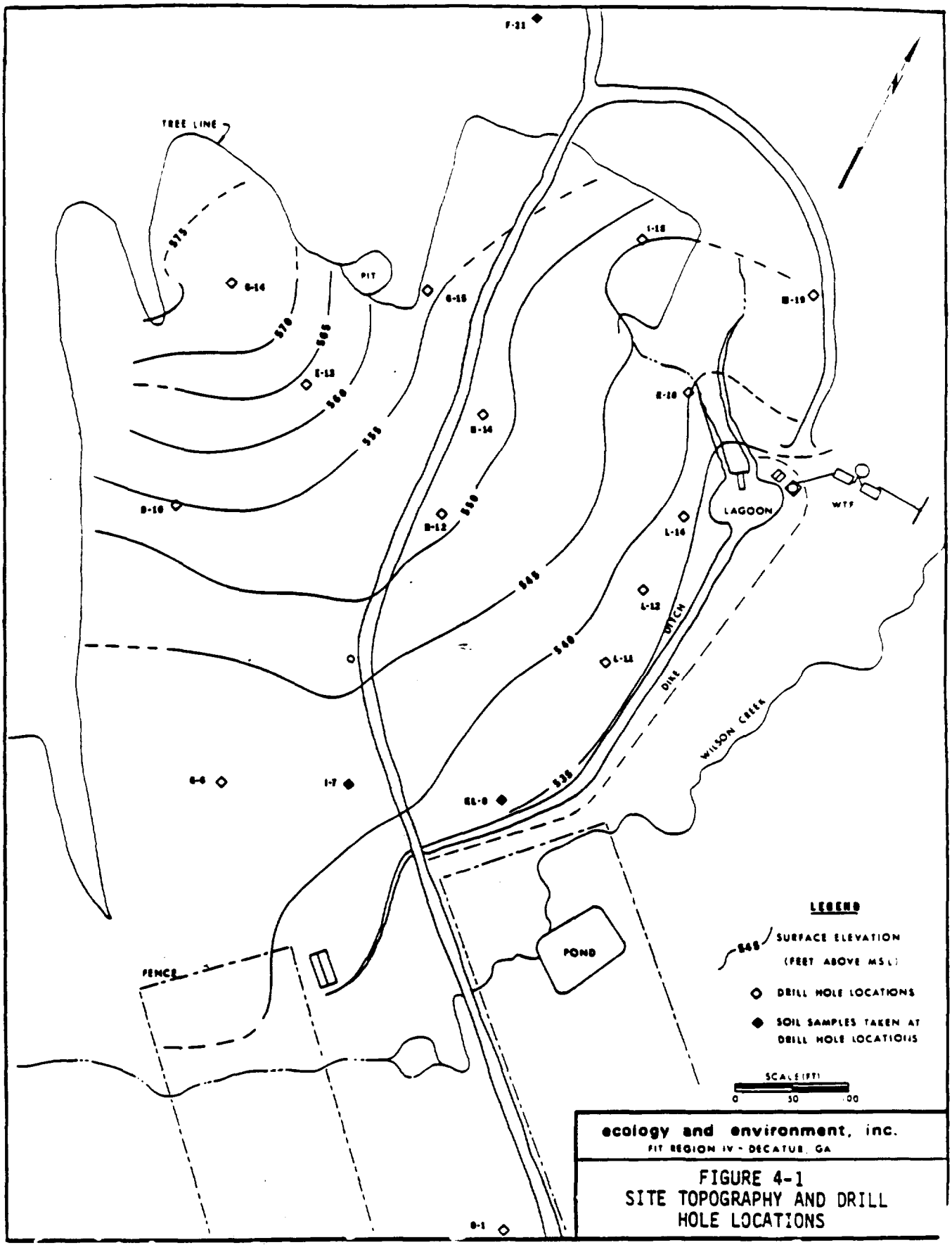

FIGURE 4-1
SITE TOPOGRAPHY AND DRILL HOLE LOCATIONS

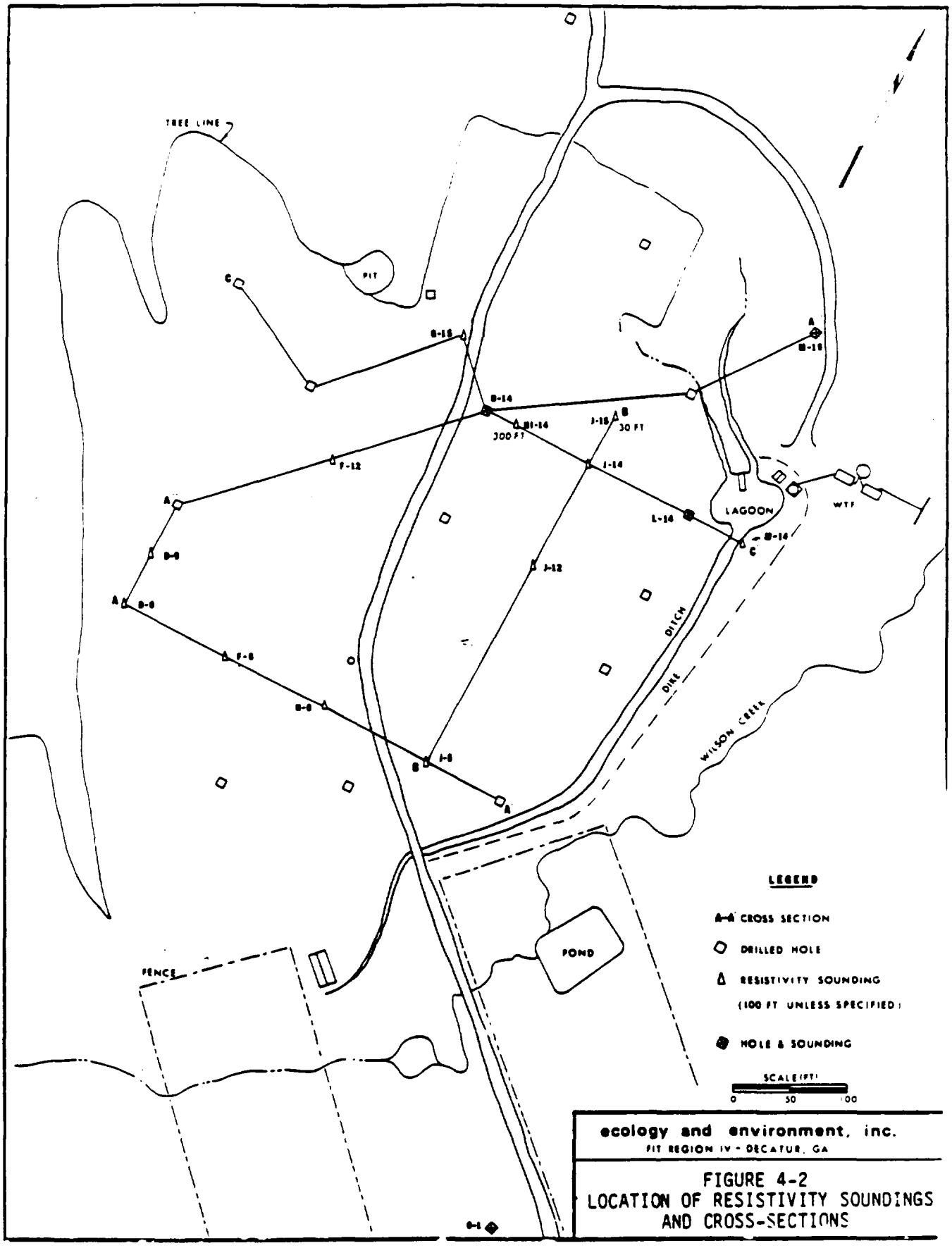

FIGURE 4-2
LOCATION OF RESISTIVITY SOUNDINGS AND CROSS-SECTIONS

- The top of bedrock, therefore, is at about 20 feet below the land surface.

- There is little ground water in the clay above the shale. Most water above bedrock occurs as soil moisture.

- There are some water-bearing fractures in the New Providence Shale. These are nearly horizontal and may be fractures, faults or bedding plane partings. They occur 30 to 35 feet below land surface, may range in length up to several hundred feet, and are probably less than 50 feet wide. The fractures are likely discontinuous, but additional data are needed to prove this. The fractures appear to be localized and do not extend over the entire area of the site. Also, they do not appear to have a vertical component which could facilitate downward transmission of ground water and contaminants into bedrock.

- An inflection is indicated on most soundings at 80 to 90 feet below land surface. This may be the contact between the New Providence and the New Albany Shales, and this contact zone appears to contain water in some places. Previous soundings, as well as the geologic literature, suggest that the New Providence Shale is about 60 feet thick at the site, which corresponds to the feature detected by resistivity soundings (Figure 4-3). The literature further indicates that the New Albany Shale probably occurs from 100 to 160 foot depths. Below it is an approximate 90-foot thickness of the Louisville Limestone, which is underlain by the Waldron Shale.

Elevations at top of shale are contoured in Figure 4-4, while a geologic cross-section derived from a combination of resistivity soundings and drill holes is shown in Figure 4-5.

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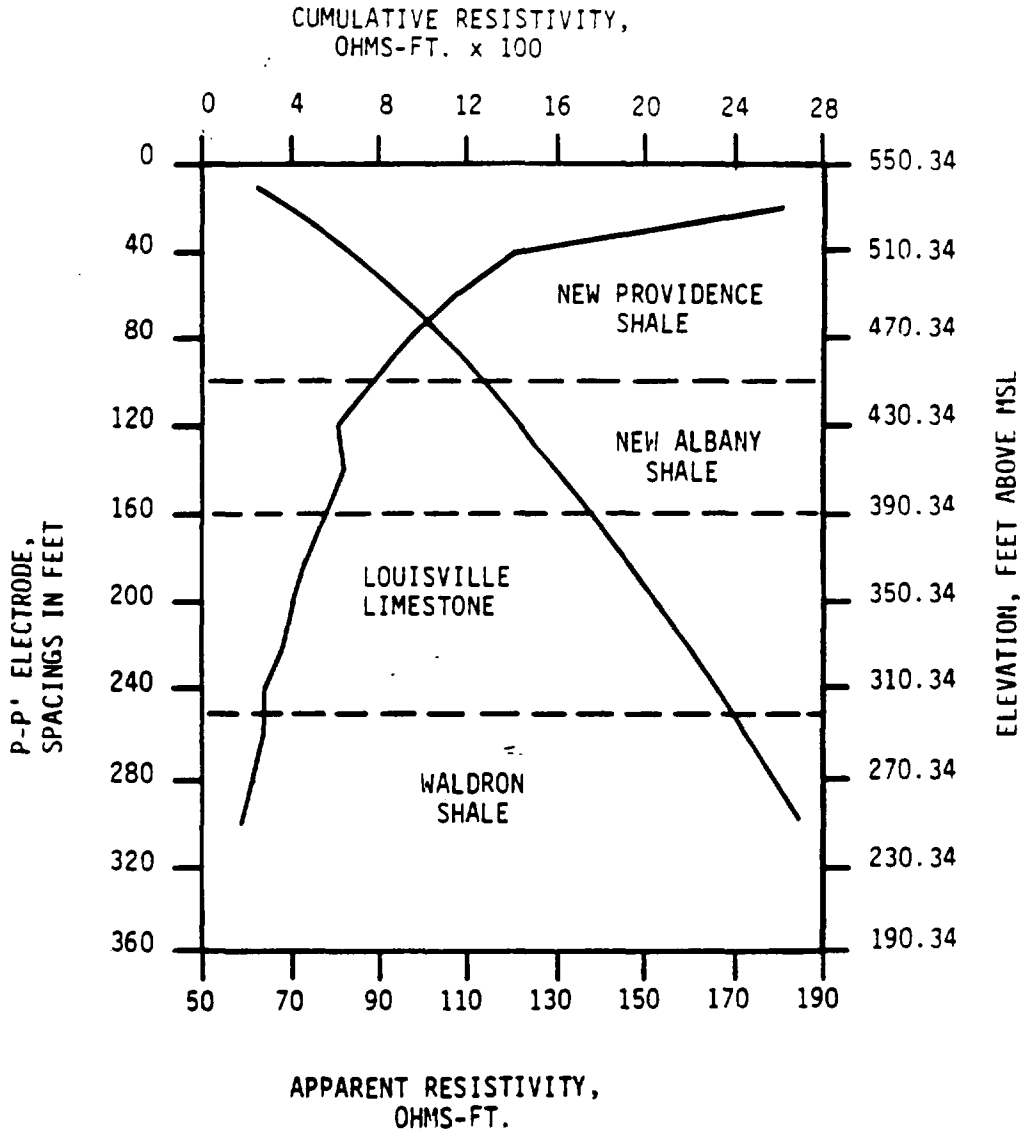

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FIGURE 4-3
TYPICAL RESISTIVITY SOUNDING

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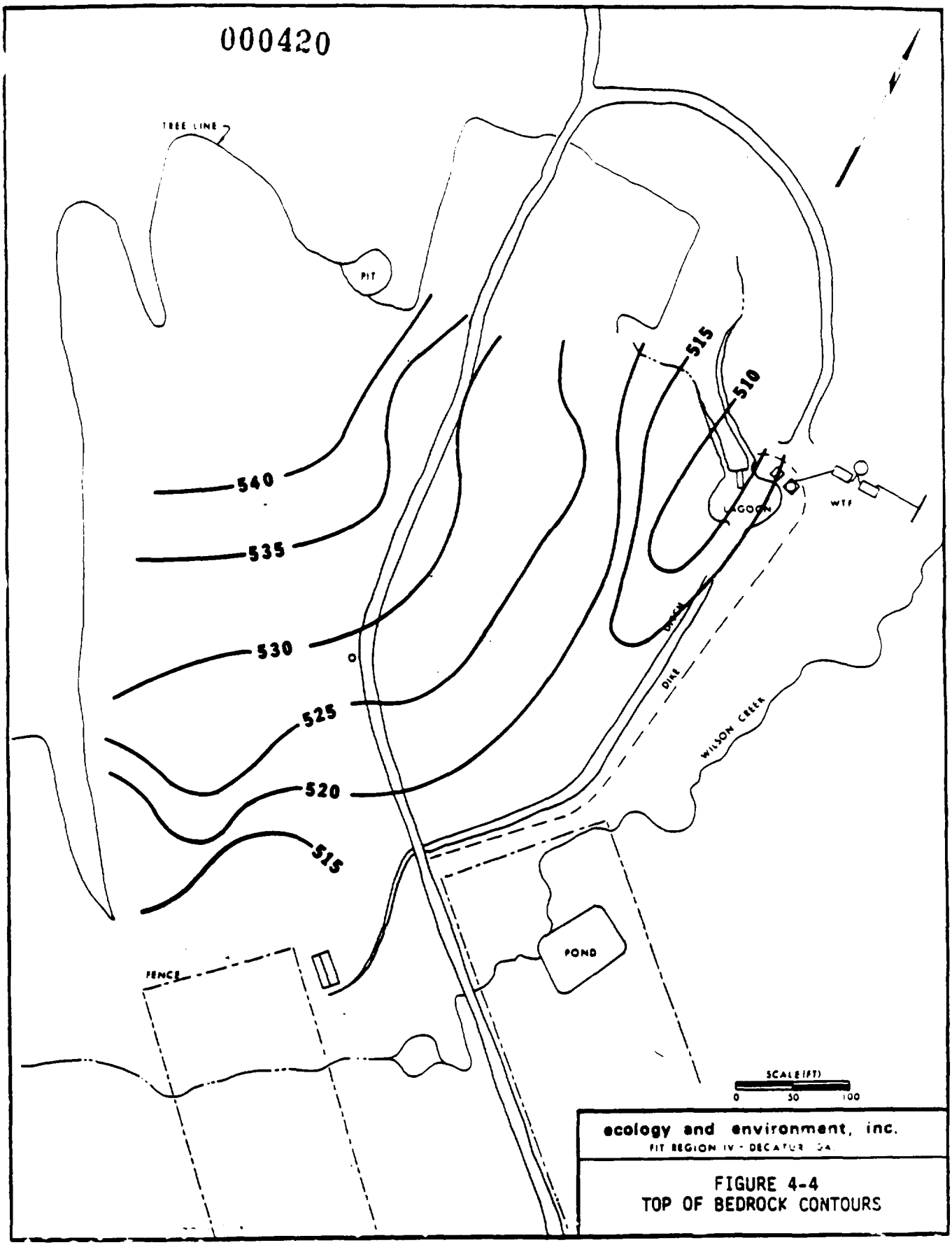

FIGURE 4-4
TOP OF BEDROCK CONTOURS

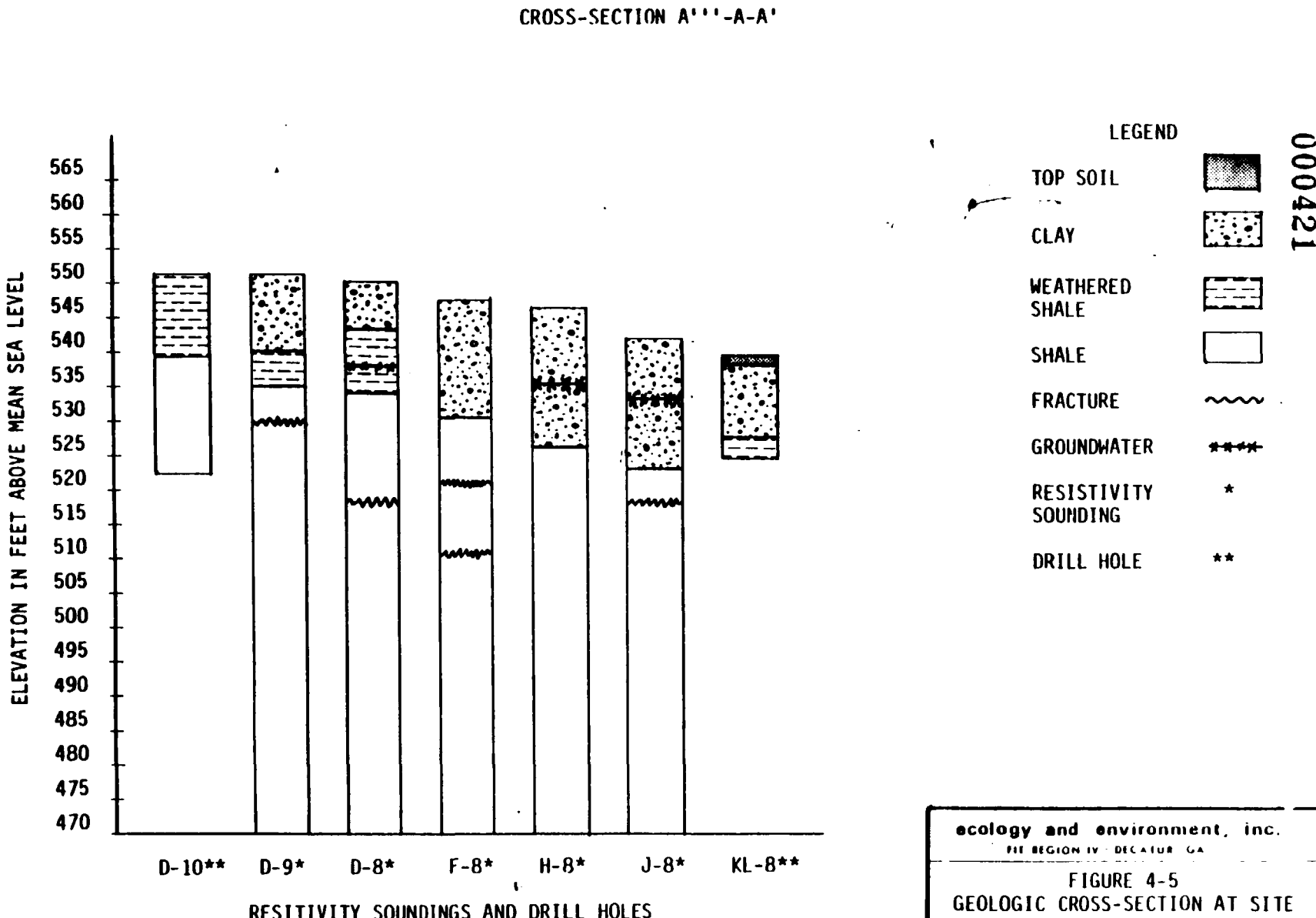

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FIGURE 4-5
GEOLOGIC CROSS-SECTION AT SITE

Magnetometer

In an attempt to locate buried drums, a magnetometer survey was conducted over the entire site on 25-foot spacings. The six anomalous areas detected are in about the same locations as TECHNOS reported, but have different configurations (Figure 4-6). The anomalous areas detected totaled about 66,000 square feet.

4.2.4 Drilling Program Results

Seventeen 6-inch wells were drilled at the locations indicated in Figure 4-2 to depths ranging from 3.5 to 29 feet below land surface. The shallowest hole and several others were abandoned during or just after drilling because the walls of the holes caved in. Except for these abandoned holes, all wells were drilled to refusal, a point interpreted to be top of unweathered bedrock. This interpretation is supported by resistivity data. Drilling logs are included in a report on field sampling (E & E, 1982).

Five of the wells were dry. Water level measurements taken from ten wells show movement of ground water is south and east toward Wilson Creek.

During drilling, only slightly damp soils were penetrated and no free-flowing ground water was noted. Water seeped into most of the wells over a period of several days. However, when Well I-7 was drilled, a perched water table was penetrated at a depth of 8 feet. Rainwater probably enters the ground through recharge areas in the adjacent higher terrain and then moves slowly through the ground, probably at or near the top of the unweathered shale and through fractures and joints in the weathered shale. In general, ground water in this type of geologic setting mostly occurs in fractures in the bedrock and is under artesian pressure.

Soils Analysis

Soil samples were taken during drilling from three of the boreholes using Shelby tube samplers. These tests indicate that soils at the site have a fair to poor subgrade rating and are high-volume-change clays of medium to high compressibility (Sowers & Sowers, 1970). The clays are nearly impervious, as shown by permeabilities of 1.5×10^{-7} and 4.75×10^{-8} cm/sec. Analytical results are shown in Table 4-1.

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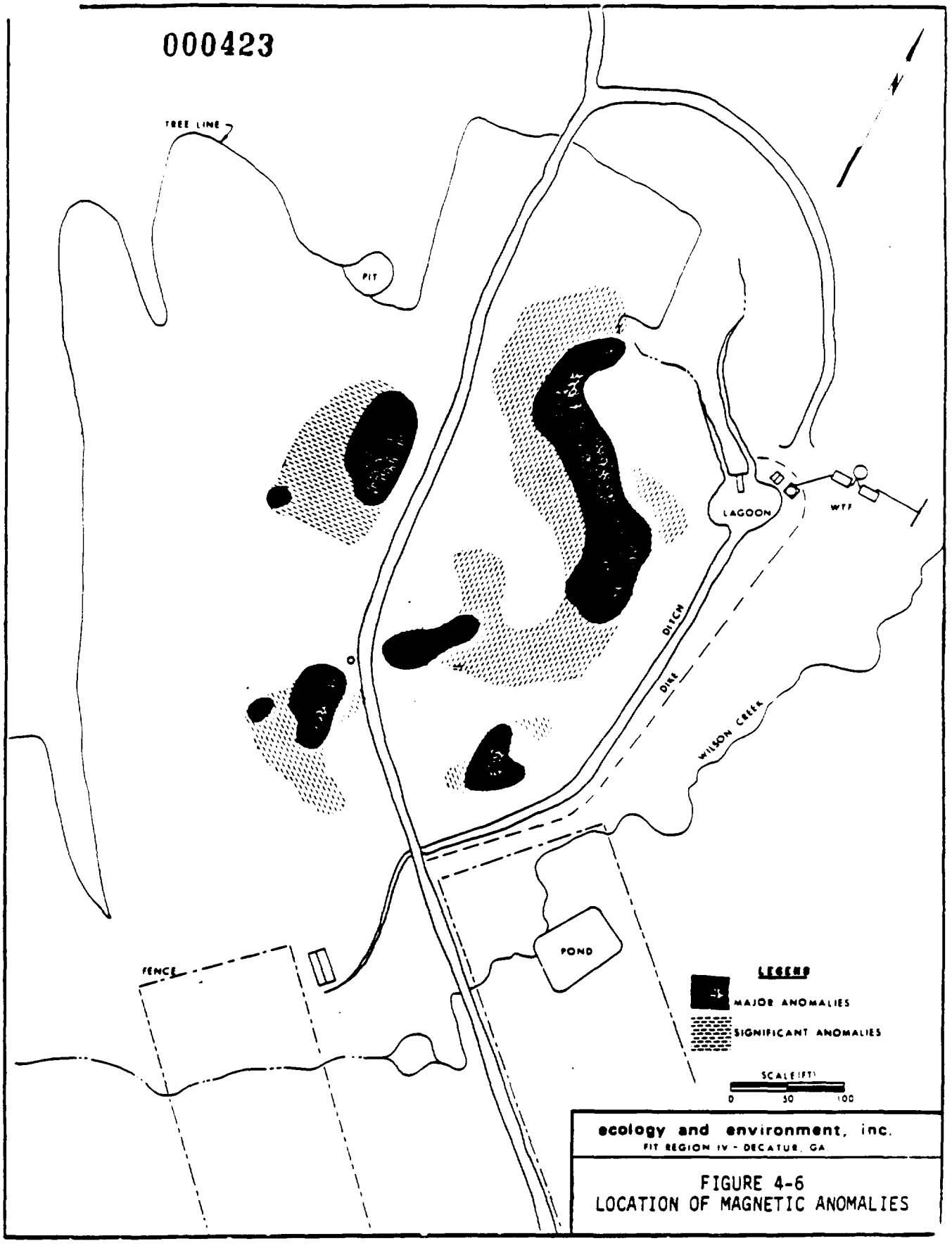

FIGURE 4-6
LOCATION OF MAGNETIC ANOMALIES

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TABLE 4-1

LABORATORY RESULTS OF
SOIL ANALYSES

ITEM	WELL HOLES I-7*	KL-8	F-21*
Depth (ft.)	1 to 3	1 to 3	3 to 4
Permeability (cm/sec)	1.5×10^{-7}	4.75×10^{-8}	2.2×10^{-7}
Moisture (percent)	21.7	19.7	21.0
Gravel	0.5	2	1
Sand	10	18	13
Silt	52	46	31
Clay	38	36	56
Colloids	20	18	42.5
Percent Finer Than			
10	99.75	98.44	99.44
40	96.81	97.47	98.67
200	95.09	94.98	97.57
Atterberg Limits			
LL	34	42	41
PL	22	22	27
PI	12	20	14
Soil Classifications			
AASHTO	AG(12)	A7-6(21)	A7-6
Unified	CL	CL	ML

*Strong smell of chemicals at these wells.

Water Analyses

Chemical analyses of ground and surface water are in progress, and results will be reported to the EPA when received. Background field measurements taken several days after drilling show that the ground water is nearly neutral (pH 6.6 to 6.7) and has a temperature of 7.2°C (48°F).

4.3 SUMMARY

The geohydrologic studies by E & E included geophysical surveys to characterize subsurface features and the drilling of shallow wells for sampling soils and ground water to test for contaminants. It was determined that about 20 feet of clay and weathered shale overlie unweathered shale in most places on the site. Data are insufficient to quantify amounts of ground water, but above bedrock it occurs mostly in the form of soil moisture. Some water probably moves through fractures and joints in the weathered shale and along the top of the unweathered shale.

The movement of ground water is from topographically high recharge areas north and west of the site towards Wilson Creek east and south of the site. Based on soil permeability, the rate of movement is 0.0475 to 0.15 feet per year. Fractures in the shale are about 30 to 35 feet deep, but these are probably relatively small, nearly horizontal, and discontinuous. Ground water from the shale is insufficient for domestic use, while water from the limestone is saline and is not used for well supplies.

Geophysical surveys indicate a stratigraphic sequence at the site, from youngest to oldest formations, as follows:

New Providence Shale (60 feet thick)
New Albany Shale (90 feet thick)
Louisville Limestone (90 feet thick)
Waldron Shale (undetermined thickness)

The magnetometer survey delineated six anomalous areas underlying an area of about 66,000 square feet. Soils analyses indicate the clay soils at the site have very low permeability and have medium to high compressibility. Chemical analyses of ground and surface water are not yet completed and will be reported when received.

SECTION 5

REMEDIAL TECHNOLOGY

Many technologies are available to intercept, treat or abate the release of pollutants from hazardous waste sites. Other technologies are available besides those discussed in this section, but they were considered unsuitable for the A. L. Taylor site, not technologically developed, or unacceptable due to expressed local public opposition. This section discusses the various technologies considered in developing the three remedial action alternatives evaluated in Section 6.

5.1 MONITORING WELLS

Post-closure monitoring of ground water under hazardous waste disposal sites is required by RCRA. Although RCRA does not apply to abandoned sites, it provides guidance on acceptable practice. As discussed in Section 4, the most likely stratum for pollution migration at the A. L. Taylor site is the weathered shale layer. The shallow ground-water system at this site transmits very little water, and the clays above and the shale below the weathered shale are considered nearly impermeable. Therefore, the weathered shale layer is the best layer for demonstrating pollutant movement in ground water.

Wells of the type shown in Figure 5-1 are the most appropriate for this site. Because of the very limited production capacity of weathered shale, a small-diameter (3.5-inch) well is desirable. Stainless steel is recommended for the casing and screen section because both chlorinated organic compounds and heavy metals are anticipated to be present in any leachate collected. A locking cap is recommended to prevent access by the public.

5.2 LANDFILL GAS CONTROL

The impact and control of gas generation at a hazardous waste landfill are a subject of great concern for which relatively little is

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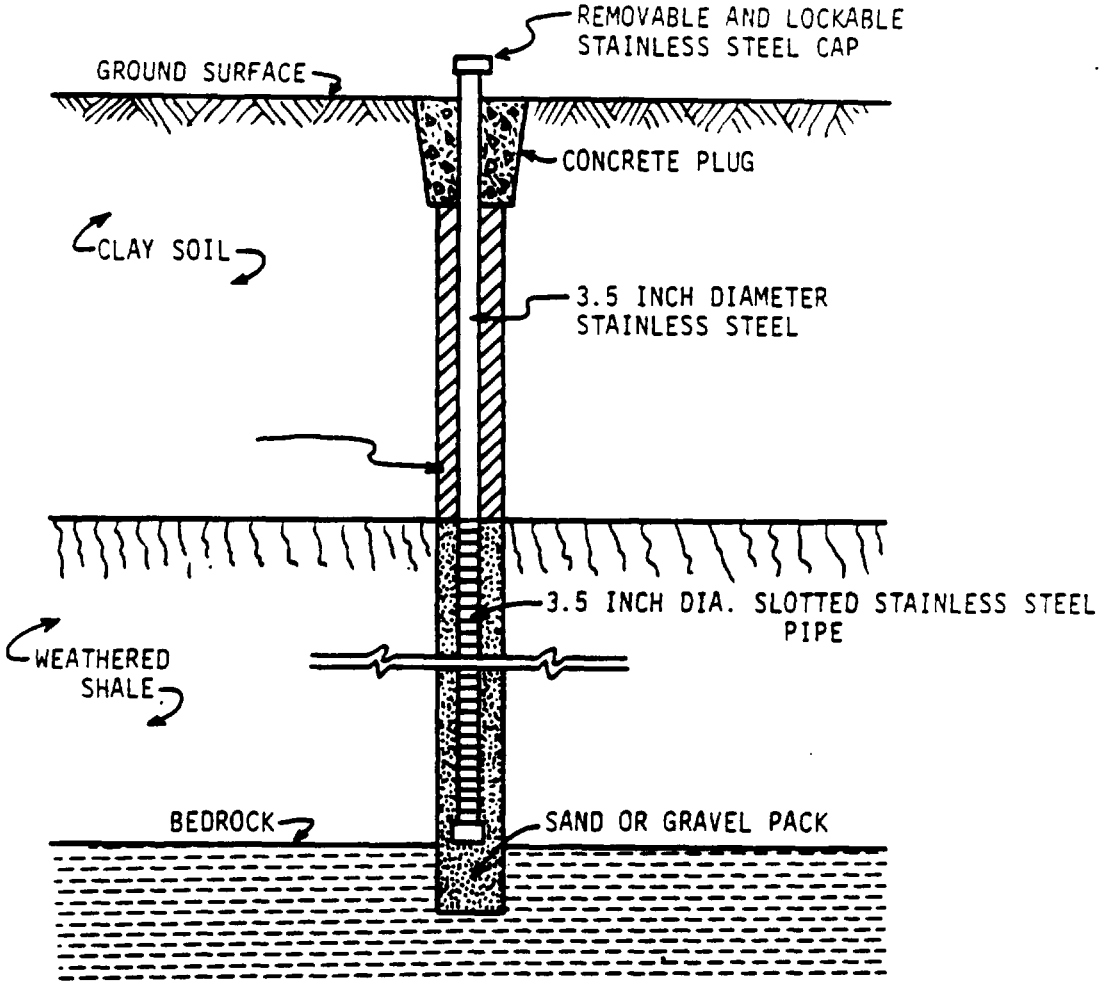

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FIGURE 5-1
RCRA-TYPE GROUNDWATER
MONITORING WELL

known. Historically, the concern over gas generation at municipal landfills has focused on methane and carbon dioxide (Anderson, 1981). However, at a hazardous waste landfill, chemical waste gases may present a much greater threat to human health and the environment.

The RCRA regulation governing hazardous waste landfills (40 CFR 267-10C) stipulates that the facility must be designed to prevent adverse effects on air quality. The extent of the potential problem and the methods used to control the gas generated at a landfill will vary widely depending upon site conditions.

A well-designed landfill and proper operating procedures are required to control gas generation. For example, a secure landfill cap and liner will reduce the escape of untreated gases to the atmosphere. Holes or cracks in the cap should be prevented since they allow the release of gases (Anderson, 1981).

Probably the most practical and effective method of gas collection in a landfill is to provide a network of collection conduit within the landfill cell. A typical conduit design might consist of several parallel perforated pipes surrounded by a porous medium such as sand and attached to a main header, which would route the migrating gases to a predetermined venting area for treatment prior to release.

Gas flow through the conduit network can run strictly on natural draft, or it can be vacuum-pumped. Since a vacuum pump is subject to mechanical failures and 30 years of maintenance and energy costs, natural draft collection is generally the most cost-efficient and reliable method. In many instances, combining the leachate collection system and the gas control system within a single network is the best approach. This is an appropriate method to collect migrating gases in the landfill cell at the A. L. Taylor site. Due to the relatively small amount of gas that is expected, this combined gas/leachate collection system should be adequate.

RCRA may require a gas monitoring and sampling program for a landfill (40 CFR 267). The sampling/monitoring program should include upwind, downwind- and offsite data for a complete and accurate assessment of gas migration control. The frequency of sampling and monitoring is

once per quarter for the first year; however, more or less frequent sampling/monitoring may be required depending on the particular site conditions. After the first year, semi-annual sampling may be appropriate.

5.3 AIR POLLUTION CONTROL

Two types of air pollution may result from activities at the A. L. Taylor site: fugitive dust and gas emissions. Up to 85 percent of fugitive dust resulting from construction activities can be controlled by frequent applications of water by sprinkling (EPA, 1977).

Landfill gas emissions may occur during construction or the post-closure period. During construction activity, real-time monitoring should be performed to protect workers and residents near the site. Workers can be protected with respirators, while local residents can be evacuated if necessary, or the release rate can be controlled by limiting the level of construction activity. Following construction, gas escaping from the leachate collection system can be controlled by sealed manholes covers and cartridge filters which are available with activated carbon and chemically reactive elements to control any anticipated emissions.

5.4 COVER MATERIAL

The basic functions of hazardous waste landfill covers are to isolate the waste and prevent rain infiltration or gas migration. If constructed of clean materials, covers also prevent exposure via direct contact with chemical contaminants. Rainfall infiltrating the waste cell and contacting the buried wastes will produce contaminated leachate that must be collected and treated. Proper design and maintenance of the cover should prevent infiltration, gas migration, freeze/thaw or dry/soak effects, cracking, differential settlement, ponding and animal burrowing. The cover must be inspected regularly to ensure that the integrity of the seal has not been breached.

There are many types of cover materials available that can be used individually or in combinations. Some of these materials are briefly outlined below (Anderson, 1981).

A compacted clay/soil mixture is generally the best landfill cover

material. Suitable soils are clean soils with a relatively large proportion of fines (i.e., particle size less than 2 micrometers). Such soil can be used as a cover material alone or after mixing with a clay such as bentonite (Landreth, 1981).

Clay is readily available, inexpensive, inert, relatively impermeable and fairly easy to install using conventional construction equipment and standard construction labor. Other types of caps require special installation equipment and highly trained labor.

A variety of admixed or formed-in-place caps is also available. These include asphalt, concrete, soil cement and soil asphalt, which are all basically hard-surfaced materials (Landreth, 1981). Actually, a clay/soil mixture can be considered an admixed material. Most of the admixed cover materials can be installed with conventional construction and road-paving equipment and standard construction labor.

There is a wide variety of prefabricated flexible liner and cap materials being manufactured today. These materials have been gaining popularity in recent years since they are strongly impermeable. Some of the polymers available are listed in Table 5-1 for reference (Landreth, 1981).

Polymers are available in panels that can be placed and joined in the field by trained personnel. A typical panel may be 100 feet x 200 feet x 80-100 mils thick. The manufacturers of the polymer sheets will recommend the seaming method that should be used with their product, but some of the various seaming techniques are heat seaming, dielectric seaming, adhesives, and solvent welds.

It is very important to prepare the ground surface properly to create a smooth base for the membrane. Experienced personnel are required to install membrane liners, and quality control during installation and seaming is important to prevent faulty seams or membrane punctures. The membrane cap should be covered with a layer of topsoil and revegetated to protect the polymer from deterioration due to direct sunlight, ozone, and mechanical puncture.

A landfill cap with a very low permeability can be created by combining a compacted admixed cover material with a membrane cover. This

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TABLE 5-1

POLYMER PRODUCERS AND SUPPLIERS

POLYMER	TRADE NAME	COMPANY
Butyl rubber		Exxon Columbian Carbon Polysar
Chlorinated polyethylene (CPE)	CPE[a]	Dow Chemical
Chlorosulfonated polyethylene (CSPE)	Hypalon	Du Pont
Elasticized polyolefin	3111	Du Pont
Epichlorohydrin rubbers	Herclor Hydrin	Hercules B. F. Goodrich
Ethylene propylene rubber (EPDM)	Epcar Epsyn Nordel Royalene Vistalon	B. F. Goodrich Copolymer Du Pont Uniroyal Exxon
Fluorocarbon polymers	Viton/Teflon	Du Pont
Neoprene	Neoprene[a]	Du Pont Denka
Nitrile rubber (NBR)	Chemigum Hycar Krynac NYsyn Paracril	Goodyear B. F. Goodrich Polysar Copolymer Uniroyal
Polybutylene (PB)		Shell Chemical
Polyester	Hytrel	Du Pont
Polyethylene - HDPE - LDPE		Many Many
Polyvinyl chloride	PVC[a]	Borden General Tire B. F. Goodrich Firestone Pantasote Stauffer Tenneco Union Carbide
Thermoplastic elastomer	Santoprene TPR	Monsanto Uniroyal
Urethane		Many

Source: Landreth, 1981

[a] Generic name

method is prohibitively expensive compared to the degree of extra security provided.

5.5 SURFACE WATER DIVERSION AND COLLECTION

Uncontrolled surface drainage can seriously damage the cap and destroy vegetation through erosion. Rainwater entering the landfill cell as a result will become contaminated and must then be treated as hazardous leachate. There are many design techniques that may be combined to create an effective flow control system. Some of these options are dikes, diversion ditches, collection/holding basins, vegetation and underground conduit.

Underground conduits are generally used in urban storm sewer systems or where the storm flow must pass under a road, driveway or other structure. Such conduits are more expensive than open channels and can present maintenance problems since the pipe is not accessible.

Open channels can range from small unlined ditches to extremely large concrete channels. Trapezoidal grassed open channels are used to divert rainwater runoff flowing over the surface of landfill cells. The drainage channel will prevent stormwater from flowing over the landfill cap in high-velocity streams that could erode the surface. Velocity-control features must also be designed into the system to prevent erosion of the channels.

Additional erosion control measures must be included in the A. L. Taylor design. The severe erosion of the existing uphill terrain must be corrected by regrading, revegetating, and removing some of the trees. Proper grooming of the surrounding area is a very important element in the success of the landfill design.

5.6 GROUND WATER DIVERSION

Ideally, a hazardous waste landfill should be located where the ground water is far below the ground surface since ground water contacting buried waste becomes contaminated leachate that must be treated. Collecting and treating large quantities of contaminated ground water are difficult and expensive and should be avoided.

Some of the available technologies for ground-water diversion are relatively new, while others have been used for many years. Any

technique used must include an impermeable barrier around the waste pits. For the barrier to be totally effective, it should extend all the way to bedrock and be keyed into the bedrock for a good seal. The following are some of the methods considered.

Steel sheet piling consists of long, flat, interlocking steel panels which are driven into the ground. Such piling, which has been used extensively on cofferdams and bulkheads, can be driven into the bedrock and interconnected to create a steel wall. In order to make the sheet piling wall watertight, it would be necessary to excavate on the outside face of the wall and seal all joints with a flexible sealing compound or inject grout at each seam. Without visual confirmation of integrity, the impermeability of sheet piling is suspect.

A continuous below-ground concrete wall or grout curtain with a sealing compound on the outside surface would be an effective groundwater diversion structure. However, deep walls that require large amounts on concrete are expensive.

Slurry wall construction is a relatively new technique in the prevention of lateral fluid flow. A narrow vertical trench is excavated while full of a bentonite slurry which will support the walls of the trench during excavation. The trench is subsequently backfilled with impervious materials to form a permanent cutoff wall. The method has proved to be effective, fast, and less expensive than other methods mainly due to reduced excavation costs. For reasons of cost, compatibility with local soils, and shale bedrock, the slurry wall appears most suited to the A. L. Taylor site.

5.7 LEACHATE COLLECTION

It must be assumed that some leachate will be produced even by a properly located, designed, constructed and managed hazardous waste landfill. However, by isolating the buried waste at the A. L. Taylor site through the use of an impermeable wall and clay cap, leachate production should be minimal.

In a hazardous waste landfill designed according to RCRA, an underdrain leachate collection system consisting of many equally spaced parallel laterals would be placed under the waste area. The collection pipe should be perforated and placed in a trench filled with a porous material. The pipe material should be durable enough to withstand concentrated leachate for the life of the landfill.

A leachate collection system for the A. L. Taylor site landfill should be installed with minimal disturbance of the buried waste. A network of perforated asphalt-coated corrugated steel pipe covered with sand and gravel should be interwoven among the buried waste pits. The system should permit gravity flow to the southeast portion of the cell where a small pumping station would pump the leachate to the treatment plant. As mentioned in Section 5.2, the leachate collection system could double as a gas collection system.

5.8 WASTEWATER TREATMENT

Collection and treatment of contaminated leachate and surface water runoff constitute a technology worth considering for remediation of the A. L. Taylor site. A properly designed system should provide complete collection and effective treatment of the contaminated water. Accordingly, the selection process should evaluate the quantity of water to be treated (design flow) and the types and concentrations of chemical contaminants present (wastewater characteristics).

5.8.1 Design Flow

Estimating the volume of runoff from this site depends on many factors including: slope, vegetation, antecedent moisture conditions, rainfall intensity, drainage area and the type and permeability of the soils. Due to the relative impermeability of the soils at the site ($<10^{-7}$ cm/sec), the leachate flow will be insignificant compared to the runoff flow component. The treatment facilities must include a flow equalization or detention lagoon large enough to store the runoff from the 5-year, 24-hour design storm, which is assumed to be 4 inches (NOAA, 1961). Using the available information on soils and topography and assuming an infiltration rate of 0.02 in/hr, the total runoff volume is

estimated to be 570,000 gallons (Linsley & Franzini, 1972). The detention lagoon should be able to store this entire volume, and the treatment facility should be able to treat it in no more than 10 days. Therefore, the treatment facility should be able to handle an average daily flow of 57,600 gallons (40 gallons per minute).

5.8.2 Wastewater Characteristics

Detailed studies to determine the chemical and physical characteristics of the wastewater have not yet been performed at the site. However, a considerable amount of data is available from environmental samples collected on and around the site as well as a few grab samples from the existing runoff detention lagoon. It is assumed that the wastewater (or runoff) will contain many of the chemicals found in these samples and that the concentration and distribution of these contaminants in the runoff will be highly variable. This variability depends on many factors including the duration, intensity, distribution and frequency of precipitation; site activities; season of the year; and erosion control. Table 1-2 lists the priority pollutants and range of concentrations that have been found in samples collected at the A. L. Taylor site.

The wastes disposed of at this site were generated principally by Louisville's coatings industry and can be divided into two groups of chemicals. The first group includes heavy metals such as chromium, lead, zinc and copper which can be found in the pigments used to formulate coatings. The second group is a long list of organic compounds including toluene, isophorone, ethyl benzene and phenol which are used in the coatings industry as bases, thinners and cleaners. Other waste materials found onsite include polymer resins, filter media waste, waste oils and dry solids.

Runoff from the site is presently characterized as containing relatively high concentrations of very fine colloidal solids. The amount of these sediments should decrease significantly when the site is revegetated. Soil tests show that 20 to 40 percent of the soil particles are classified as colloids, and at least 95 percent of the grains will pass through a #200 mesh screen.

Two other important parameters for designing the treatment facilities are the gross measurements of chemical oxygen demand (COD) and total organic carbon (TOC). Based on the samples collected from the detection lagoon in December, 1981, and analyzed by Resource Recycling Technologies, Inc., these parameters are about 700 milligrams per liter (mg/l) and 130 mg/l, respectively (RRT, 1982). With this information in mind, a review of unit processes is in order to select a suitable treatment system.

5.8.3 Unit Operations

Sedimentation

Sedimentation is the physical separation of suspended particles in water by gravitational settling. Regardless of which chemical, physical or biological process is used to treat the organic contaminants in the wastewater, effective removal of the colloidal solids should be accomplished. These solids cannot be settled without chemically aided precipitation to produce a floc which is heavier than water. A thorough jar-testing program should be conducted to select the best flocculant and the optimum concentration of this additive. Flocculation is promoted by gentle stirring with slow-moving paddles which will increase particle contact but will not agitate the wastewater too vigorously causing shear forces that will break up the floc. Design considerations should be based on the settling characteristics determined by the jar tests. Based on average design factors, a detention time of 1 hour and a paddle tip speed of 2.5 feet per second, this unit will require a 1-horsepower motor, 8 square feet of paddle area, and a volume of 320 cubic feet (Metcalf & Eddy, 1974).

Mechanical flocculation of the colloidal solids has many disadvantages for application at the Taylor site. These include a high level of operator attention and experience and high cost associated with construction, chemical addition and power requirements. Baffled flow channels have been used for flocculation and avoid operator attention and power consumption; however, these channels are difficult to design. Therefore, a mechanical system should be built only after it has been shown that this level of treatment is absolutely necessary.

Some sedimentation will occur in the detention lagoon without requiring expensive new construction. To optimize sedimentation, an outfall structure should be built in the lagoon with gate valves at several levels so the withdrawal level and rate of flow can be adjusted to obtain the optimum effluent quality. This system, however, would reduce the effective storage volume of the detention lagoon, but may be the most cost-effective option for reducing solids.

Biological Treatment

Other than sedimentation, biological units are the most common type of wastewater treatment. However, aerobic biological treatment is not recommended since it would be difficult to grow and maintain an adequate population of microorganisms with the flow conditions and pollutant charactersitics at this site. Anaerobic biological treatment is not recommended because of its odor problems.

Carbon Adsorption

Carbon adsorption is ideally suited for this application for many reasons:

- It is basically a simple process and therefore is quite reliable.
- It will tolerate highly variable hydraulic and organic loads.
- It is not generally subject to seasonal variation in effluent quality due to temperature extremes.
- Activated carbon is particularly effective in removing a wide range of organic compounds from aqueous solution.

Among this system's disadvantages is the fact that a thorough pilot testing program is required to develop an effective design and predict operating costs. Also, some organic chemicals present as site pollutants would stress the adsorption capacity of carbon, and breakthrough of some compounds may occur. Nevertheless, this process is recommended for organics removal at this time because the existing carbon adsorption system has been shown to be effective under optimum conditions. Many

different contactor designs are available and can be evaluated once the design parameters are established by pilot-testing different activated carbon products, bed depths, recirculation rates and carbon replacement times (EPA, 1973).

Aeration

Wastewater aeration, probably using surface aerators in the detention lagoon, may be useful for treatment of this wastewater and should be evaluated. This simple, reliable and relatively inexpensive unit process may be an effect treatment method since it promotes the release of volatile organics, provides enough oxygen and mixing to oxidize some compounds, and maintains a sufficient oxygen level to allow biological treatment of the biodegradable constituents. The main disadvantage is that it contributes to air pollution by releasing volatile organic compounds into the air.

The total constituents in the wastewater which are either volatile, oxidizable or biodegradable are not well known. Therefore, it is difficult to assess the effectiveness or even the suitability of this unit process. However, it is known that activated carbon is exceptionally well suited for the treatment of dissolved organics (those which pass through a 0.45-micron membrane) and that generally either sedimentation or aeration would be effective in reducing most other constituents in this wastewater.

Based on the start-up evaluation of the existing system performed in December, 1981, this unit process appears to be very effective in reducing the chemical oxygen demand of this wastewater. Resource Recycling Technologies, Inc., placed a small aerator in the lagoon and reduced the influent COD to the treatment facilities by more than 50 percent.

Filtration

Rapid sand filtration is presently used at the A. L. Taylor site and is not very effective in reducing the solids concentration. Simple sand or multi-media filters should not be used for this application because of the particle sizes found in this wastewater. Ultrafiltration and reverse

osmosis type systems may be very effective in reducing the solids as well as larger organic molecules. However, these systems are very costly, are difficult to operate and maintain, and therefore should be used only if other processes are not adequate.

SECTION 6

ALTERNATIVE EVALUATION

The remedial designs evaluated in this section were identified following assessment of the remedial concepts discussed in Section 5. E & E and the EPA staff discussed these concepts and selected design elements generally suitable to site-specific conditions, funding, and local public opinions. This section presents a detailed description and a cost-benefit evaluation of the three following remedial designs:

(1) Minimum Action Alternative

(2) Onsite Containment Alternative

(3) Excavate-and-Relocate Alternative

A detailed development of each remedial alternative is presented below followed by a comparison in Section 7.

6.1 MINIMUM ACTION ALTERNATIVE

The minimum action alternative consists of the following elements:

(1) Leaving all buried wastes in place

(2) Regrading and revegetating the existing site surface

(3) Removing wastes from the open pit and surface dumping area northeast of the site

(4) Establishing a ground-water monitoring program

(5) Operating and maintaining the existing runoff collection and treatment system

(6) Preparing and filing a record plat.

This alternative is developed as a baseline comparison for the other two alternatives and is not intended to meet the requirements of a RCRA facility. Those actions listed above are directed at maintaining the status quo except for Item 3. The removal of the open pit and the surface dumping area will provide some environmental improvement. The open pit is being removed for safety and engineering reasons discussed later, while the surface dumping area is being cleaned up because it is outside the drainage area captured by the runoff collection trenches and detention lagoon.

6.1.1 Alternative Description

Site Cover

At the end of the 1981 emergency action the site was partly regraded, and native soil was spread over the buried waste cells. Portions of the surface soils are dark brown to black in color, while natural clay soils in the site area are light tan in color. This fact, plus the high levels of chemical oxygen demand found in the surface water runoff, leads to the conclusion that the surface soil is contaminated.

The level of contamination is unknown but not believed to be acutely dangerous.

The natural clay soils of the site have a very low vertical permeability of less than or equal to 10^{-7} cm/sec. Such soils are suitable for cover material; however, the disturbance caused by the regrading in 1981 will have increased the permeability of the soil. Furthermore, the soil thickness over buried wastes is not known and contaminated surface soils are still present. Therefore, the existing soil cover cannot be considered acceptable when compared to RCRA guidelines.

Following minimal regrading, the existing cover will be revegetated to reduce erosion and improve aesthetics. The recommendations of the Soil Conservation Service of the U.S. Department of Agriculture will be followed in revegetating the site. Some slopes on the northwest corner of the site are so steep that no natural erosion control can be accomplished without major earth-moving operations. Therefore, no erosion control is recommended except tree and shrub plantings at the bottom of these slopes.

Open Pit and Surface Dumping Area

The small open pit was constructed by placing an earth dam across a small gully or natural drainageway in an upland hillside. This pit, located in the north-central portion of the site, is filled with what appears to be resins and gelatinous paint materials. The pit will be excavated using standard construction practices, and all the hazardous material and contaminated soil will be disposed of in an approved facility. It is necessary to remove the pit because it represents a safety hazard to the casual site visitor and is exposed to the atmosphere and rainwater. The pit's removal will also reduce the runoff loading to the wastewater treatment system. The option of covering the pit with soil was eliminated because of erosion control difficulties associated with maintaining the cover in a natural drainageway.

In addition, the small surface dumping area which has caused vegetation damage northeast of the site will be removed. This area,

about 50 by 100 feet, will be excavated because it is outside the runoff catchment and treatment area.

The waste material from both excavations will be transported in bulk to a secure landfill (see Section 6.3.1). Both the pit and the dumping area will be backfilled to original grade using imported fill material.

Ground Water Monitoring

Subpart F of Section 264 of the RCRA regulations provides specific guidance for establishing a ground-water monitoring program for the 30-year post-closure period. Four permanent ground-water monitoring wells will be constructed, one hydraulically upgradient from the waste burial areas and three hydraulically downgradient. A small-diameter well will be drilled to the depth of refusal in the unweathered shale formation (approximately 20 feet). Wells will be constructed according to EPA criteria for hazardous waste site monitoring wells discussed in Section 3. This system will be capable of characterizing background ground-water quality and detecting any contaminant migration from the waste burial sites at a minimal cost. The results of the hydrologic study and sampling data discussed in Section 4 will be used to determine the optimum placement of these monitoring wells.

A sampling and analysis plan will be prepared and followed by the State or other designated operating authority for the 30-year post-closure period. As a minimum, this plan will include procedures and techniques for (1) sample collection, (2) sample preservation and shipment, (3) analytical procedures, and (4) chain-of-custody control. Specific analytical parameters will be determined based on the results of ground-water samples collected in January, 1982, but not yet analyzed. As a minimum, these parameters will include pH, specific conductance, total organic carbon, total organic halogen, and chemical oxygen demand. During the first year, these wells will be sampled and analyzed quarterly to establish a statistically valid baseline for each parameter. After the first year, these wells will be sampled and analyzed at least twice yearly.

Runoff Collection and Treatment Facilities

For this alternative, the existing runoff collection and water treatment facilities will remain on the site for the remainder of their useful life, approximately 5 years. Figure 6-1 shows a schematic diagram of these facilities, and Table 6-1 summarizes the major design considerations. The facility performance will be evaluated by sampling both influent and effluent at least twice yearly concurrent with the ground-water monitoring program. A decision will be made at an appropriate time within the period of continued operation to either remove the facility or replace it with a re-designed facility. This decision will be based on performance as measured by influent and effluent quality and the condition of the equipment. For the purpose of this study, the plant is assumed to be removed and not replaced at the end of the fifth year.

Site Security and Safety

No additional security measures have been designed for this alternative, with the exception of a warning sign to be posted on the existing locked gate at the entrance to the site. The final step in site closure will consist of documentation of the location of the site and the activities which took place there. The site will be surveyed and a record plat prepared which will include a warning that this is a hazardous waste site, that the wastes have not been removed and that caution must be used in future use of the land. The plat will be filed in the public records of Bullitt County. Pursuant to Subpart G of Part 264 of the RCRA regulations, this notation must warn that federal law limits post-closure use of the property by anyone in a manner that would disturb the integrity of the cover, the treatment facilities, or the monitoring systems at this site.

6.1.2 Alternative Evaluation

This alternative was not specifically designed to meet the minimum requirements of the most recent RCRA regulations regarding closure of landfill facilities. The following subsections discuss in more detail the environmental protection effectiveness, reliability,

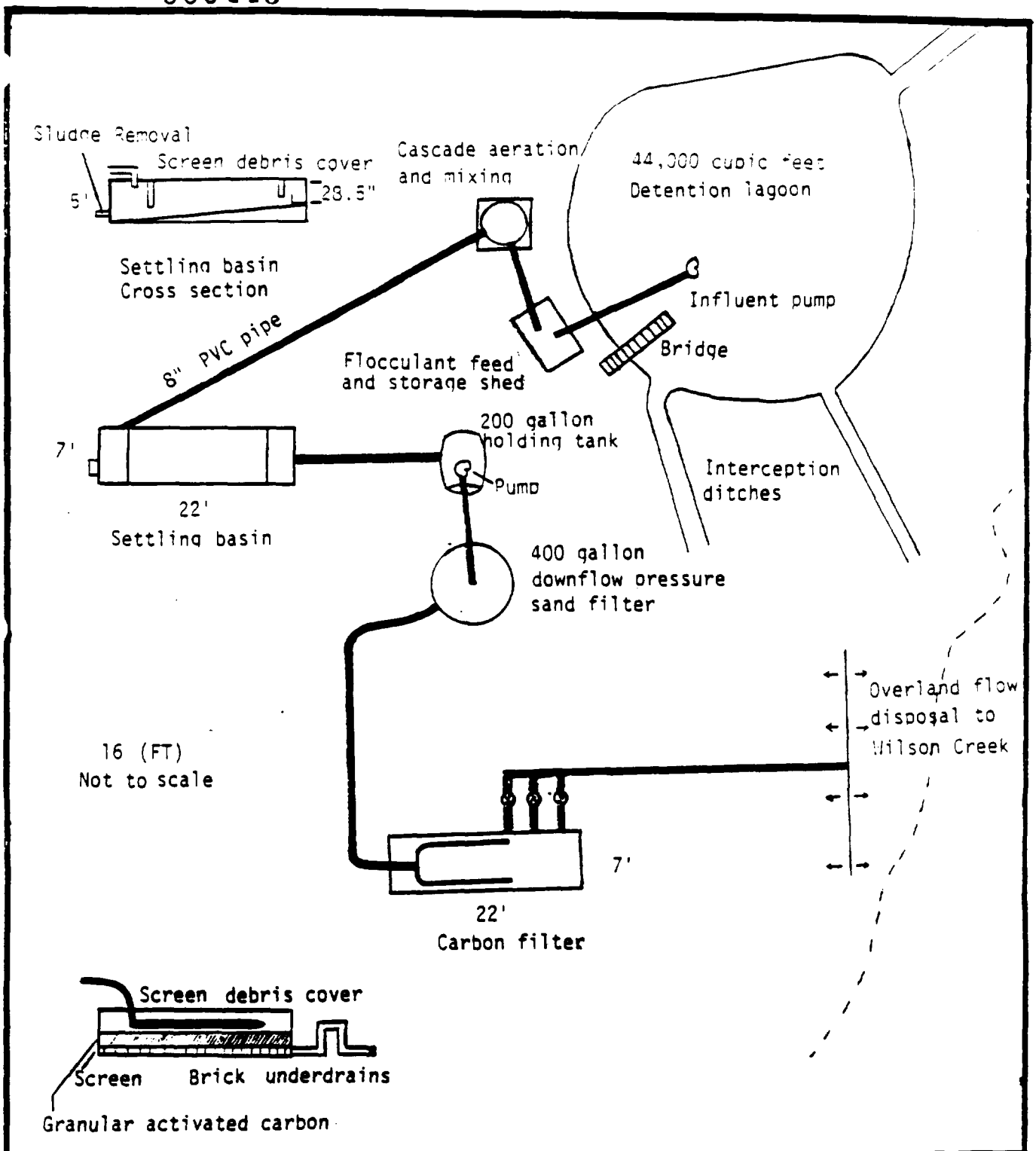

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FIGURE 6-1
SCHEMATIC OF EXISTING
WASTEWATER TREATMENT PLANT

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TABLE 6-1

DESIGN CONSIDERATIONS
LEACHATE AND RUNOFF TREATMENT FACILITIES
A. L. TAYLOR SITE, BROOKS, KY

Detention Lagoon: Designed to provide storage and flow equalization for a 2-inch storm with an 85% runoff coefficient.	
A. Volume	44,000 cu. ft.
B. Dimensions	Approximately 0.10 acres x 12 feet deep
C. Construction	Excavation, natural clay bottom
Influent Pump:	
A. Type	Submersible
B. Operation	Automatic with float controls, or manual
C. Head	Approximately 22 ft.
D. Flow rate	100 gpm max., 30 gpm average
Flocculant Feed: Flocculant is mixed in the storage shed and then fed directly into the influent pipe.	
A. Flocculant	Alum
B. Mixing tank	55-gal drum with portable mixer.
C. Feed rate	250 ml/min @ 10% stroke
Rapid Mix: Rapid mix and pre-aeration provided by cascade type system.	
A. Dimensions	10 feet diameter x 2 feet deep galvanized steel tub
B. Retention time	Approximately 10 min. @ Q_{av}
Settling Basin:	
A. Dimensions	7' x 22' x 5' deep above-ground steel tank
B. Retention time	Appproximately 130 min @ Q_{av}
C. Sludge handling	Sloped bottom collects sludge which is removed with a portable pump and recycled to the detention lagoon.

TABLE 6-1 (continued)

DESIGN CONSIDERATIONS
LEACHATE AND RUNOFF TREATMENT FACILITIES
A. L. TAYLOR SITE, BROOKS, KY

Filtration: Settling basin effluent flows into a 200 gal. fiberglass holding tank before being pumped to the filter.

A.	Type	Skid-mounted steel downflow pressure filter.
B.	Volume	400 gal.
C.	Media	Graded coarse to medium-fine silica sand
D.	Backwash	Manually using portable pump as needed.

Carbon Filter: Gravity feed from sand filter to manifold influent distribution system.

A.	Dimensions	7' x 22' x 5' deep above-ground steel tank.
B.	Media	Approximately 500 cu. ft.
C.	Underdrain system	Standard 4 in. bricks covered with fine screen.
D.	Hydraulic loading	Approximately 0.20 gpm/sq. ft.
E.	Bed depth	Approximately 40 inches
F.	System design	Downflow packed bed, gravity, open
G.	Backwash	None
H.	Carbon regeneration	None, top layer of carbon is replaced as needed.

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implementability, safety, and operation and maintenance effects of the actions specified in this alternative, relative to criteria described in Section 2.

Environmental Protection

Undisturbed samples of the regraded soils were collected and analyzed for permeability in January, 1982. These show that the existing clay cover on site could provide substantial protection from surface water infiltration if properly placed in sufficient thickness. However, sufficient information is not available to determine that the existing cover will prevent infiltration or gas release or will keep water from direct contact with the wastes. The recommended revegetation program should be effective in enhancing the aesthetics of the site, controlling erosion, and reducing both the quantity and contaminant concentration of runoff to be treated. Some areas of the site may be difficult to revegetate because of suspected surface soil contamination, and some erosion will continue on the steep slopes north and west of the site. The erosion of these areas will be monitored over the years and remedial actions taken when necessary.

Effluent samples were collected on December 8, 1981, from the existing treatment facilities constructed in September, 1981. Resource Recycling Technologies, Inc., analyzed these samples and concluded that no significant quantities of priority pollutants were present in the treated water and therefore, the effluent did not pose any problems to water quality (see Table 6-2). It was also found that the existing treatment facilities, without aeration, discharged effluent with a chemical oxygen demand (COD) of about 300 ppm and that the effluent contained no heavy metals above detection limits. Therefore, the facilities are assumed to be providing good treatment of toxic pollutants and significantly reducing the COD of the runoff (RRT, 1982).

It should be noted that the above sampling was conducted under optimal conditions when the plant had been recently refurbished. The concentration of COD still being discharged to this small stream may significantly affect the oxygen resources of Wilson Creek. Since the refurbished plant operations began in December, 1981, design and

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TABLE 6-2

EFFLUENT QUALITY OF THE EXISTING TREATMENT PLANT

A. COD VALUES FOR A. L. TAYLOR SITE (12/9 - 12/12/81)

SAMPLE NO.	LOCATION	TIME	COD	pH
1	Effluent	12-09-81; 1600 hrs	40 mg/l	6.1
2	Effluent	12-10-81; 0900 hrs	40 mg/l	6.0
3	Effluent	12-10-81; 1130 hrs	100 mg/l	6.5
4	Effluent	12-10-81; 1400 hrs	110 mg/l	6.5
5	Lagoon	12-10-81; 1100 hrs	400 mg/l	6.7
6	Effluent	12-10-81; 1130 hrs	100 mg/l	6.5
7	Effluent	12-10-81; 1600 hrs	110 mg/l	
8	Effluent	12-11-81; 0800 hrs	125 mg/l	6.5
9	Lagoon	12-11-81; 0930 hrs	360 mg/l	6.5
10	Effluent	12-11-81; 1130 hrs	110 mg/l	6.6
11*	Effluent	12-11-81; 1430 hrs	75 mg/l	6.7
12	Lagoon	12-11-81; 1430 hrs	375 mg/l	6.7
13	Effluent	12-11-81; 1600 hrs	75 mg/l	6.6
14	Lagoon	12-11-81; 1600 hrs	385 mg/l	6.7
15	Effluent	12-12-81; 1100 hrs	85 mg/l	7.7
16	Lagoon	12-12-81; 1100 hrs	400 mg/l	6.8
17	Lagoon	12-12-81; 1300 hrs	375 mg/l	7.0
18	Effluent	12-12-81; 1300 hrs	90 mg/l	7.7
19	Effluent	12-12-81; 1555 hrs	95 mg/l	8.0
20	Lagoon	12-12-81; 1555 hrs	400 mg/l	7.0

NOTE: All above values were determined after increased charge of carbon.
*There was modification of carbon filtration system which caused reduction in COD.

B. PRIORITY POLLUTANT AND METALS ANALYSIS

METALS

Cd	=	<0.1 mg/l
Pb	=	<0.5 mg/l
Cr	=	<0.05 mg/l
Zn	=	<0.05 mg/l
Cu	=	<0.05 mg/l
As	=	<0.002 mg/l
Se	=	<0.005 mg/l
Ba	=	<0.1 mg/l
Hg	=	<0.0002 mg/l

PRIORITY POLLUTANT

Di-N-Octyl Phthalate = 56 ug/l
(only priority pollutant measured above chronic toxic, limits, EPA 440/5-80-067

operational problems have occurred. The heavy rains in Louisville during the winter of 1981-82 caused the detention lagoon to overflow several times. It can be assumed that the treatment efficiency will not always be as good as that reported in the above analyses. In summary, the existing treatment plant with modifications and proper operation could provide substantial pollution control of the runoff from the A. L. Taylor site.

Removal of wastes from the small open pit and surface dumping area would be effective in removing this potentially significant source of air and water contamination. Since the surface dumping area is outside the drainage captured by the treatment plant, its removal should eliminate releases to the surface water. Removal of the pit will improve site safety and reduce the treatment load of the wastewater treatment system.

Reliability

The option of performing minimal cleanup has limited reliability. Significant quantities of wastes will remain at the site without constraints other than the naturally occurring geological and hydrological conditions. The undisturbed natural clay is relatively impermeable; however, it is not known with any degree of accuracy if the weathered shale below the clay is an active pathway for migration or whether wastes are buried below the clay layer in the weathered shale. Slow leachate migration in the weathered shale zone is suspected. The analysis of samples taken in January, 1982, to determine this has not been completed.

The buried wastes are covered with natural soils taken from other areas of the site. The soil cover depth over the burial sites is not known, and the permeability data obtained from undisturbed soil samples may not be representative of soils used for cover. Cover failure could result in direct surface-water contamination, rainwater infiltration, and leachate generation.

The existing treatment facility has experienced unfavorable operating conditions, particularly in the winter season. Overflows of the runoff detention lagoon have resulted in direct discharge of

untreated site runoff to Wilson Creek. Such problems could recur without modifications to the treatment facility.

For the above reasons, mitigation of potential releases can be accomplished only by continued monitoring of site conditions and taking corrective actions when and if they are indicated in the future.

Implementability

Several legal constraints may seriously interfere with implementing this alternative. Control and ownership of the land or permission to construct and maintain controls on site have not been permanently defined. One legal question raised by the local and regional planning agencies is appropriate zoning. The site is currently zoned for agriculture, while a treatment plant should be placed in an industrially zoned area. The degree of public acceptance of a zoning change is difficult to predict. Furthermore, the status of this facility under RCRA-permitting procedures must be determined by the EPA and the State of Kentucky.

RCRA Conformance

The minimum action alternative does not conform to the RCRA guidelines in three major ways. First of all, site security is limited to an entrance gate with warning sign. The site is not fenced because of a restriction placed on EPA by the Taylor estate which prevented fencing. Secondly, the site cover does not meet minimum criteria for prevention of infiltration, erosion or direct contact. In addition, the treatment plant has several shortcomings which are identified in Table 6-3 from discussions with Kentucky operating personnel and E & E's own evaluation. These problems could result in nonconformance with RCRA guidelines for such treatment facilities. Table 6-3 also presents several recommended solutions to the problems. A thorough plant evaluation and complete upgrading recommendation, however, is beyond the scope of this report.

Safety

Safety considerations in the accomplishment of this alternative are limited to potential worker exposure while excavating the small pit

TABLE 6-3

TREATMENT PLANT EVALUATION AND RECOMMENDATIONS
A. L. TAYLOR SITE, BROOKS, KY

PROCESS EFFECTIVENESS	RECOMMENDED IMPROVEMENTS
Sedimentation	
A. Alum addition lowers pH of effluent below acceptable limits.	Other polymers should be tested and used if suitable and cost-effective. Or lime must be added to make enough alkalinity available to maintain the effluent pH. Approx. 4.5 mg/l alkalinity as $CaCO_3$ is required to react with 10 mg/l of alum.
B. Alum feed pump empties mixing tank in less than 12 hours at lowest setting.	Reduce flow rate by recycling alum, and larger tank is required with present system. However, direct feed of dry or liquid alum without pre-mixing is more effective.
C. Erosion of support structure has caused cascade mixing tank to split and leak badly.	Tank should be supported by wooden sides or eliminated entirely.
D. System does not produce a settleable floc.	The gelatinous aluminum hydroxide floc probably forms and partially settles in the mixing tank before contacting the wastewater. Alum (or polymer) should be fed directly into the influent pipe and mixed by the turbulent flow. The floc must be allowed to form by slow mixing in a baffled channel or paddle-stirred tank before entering settling basin.
E. Buried drum designed for handling has floated out of the ground.	Concrete or other more permanent sludge pit should be constructed.

TABLE 6-3 (continued)

TREATMENT PLANT EVALUATION AND RECOMMENDATIONS
A. L. TAYLOR SITE, BROOKS, KY

PROCESS EFFECTIVENESS	RECOMMENDED IMPROVEMENTS
Filtration	
Existing rapid sand filter does not remove suspended collodial solids.	Revegetate the site to eliminate some solids at the source. A good sedimentation system would eliminate the need for this step if followed by carbon filter. Convert the settling basin to a slow mix chamber and use the sand filter to remove floc. An excellent backwash system would be necessary for this operation.
Carbon Adsorption	
This system is capable of significantly reducing the COD and priority pollutants but is costly to operate.	Effluent COD should be analyzed regularly to determine when the carbon needs replacing. If carbon regenerating facilities (multiple hearth furnace) are available locally, compare this alternative to replacement with new carbon. Install aerator in the lagoon to reduce the COD load to the carbon adsorption system.
Other Problems	
Pond overflows occasionally during cold weather when plant cannot be operated unless attended.	Install an overflow pipe from pond to protect the dike from erosion and washout. Leave light on in shed and partially bury tanks or cover with spray foam insulation to protect against freezing temperatures.

onsite and the surface dumping area northeast of the site. Fire, explosion and direct contact exposures can be controlled by following proper safety practices. Traffic accidents and resultant spills may occur in transporting the waste to an approved disposal facility. This risk will be mitigated by standard spill response procedures.

Operation and Maintenance

Continued operation and maintenance of the existing treatment facility will be similar to current practices. This commitment will consist of 4 to 6 labor days per month of operation time during the dry season and 6 to 12 days during the wet season. The problems of freezing and vandalism will continue. Operation and maintenance could be greatly assisted by the preparation of a plant operations manual. Ground water sampling will be performed four times the first year and twice yearly thereafter for 29 years according to standard procedures.

6.1.3 Preliminary Environmental Evaluation

Topography

The minimum action alternative involves minor regrading of the existing disturbed area of the A. L. Taylor site to eliminate the severe erosion pathways and small depressions prone to ponding. The open pit will be excavated and backfilled to existing contours. The degree of regrading is limited only to the few problem areas seen as inhibitors for successful revegetation. The steep banks on the northern and western border of the subsurface contamination zone will not be altered, and the existing average 7 percent site slope towards Wilson Creek will be maintained.

The 50 x 100 foot surface dumping area northeast of the site will also be excavated and backfilled with clean soil. The minimum action alternative calls for revegetating this section without modifying its topographic characteristics.

Soils

The existing soil will be left in place and not disturbed further except for the small pit and surface dumping area excavation. No additional cover will be added, and no soil displacement will occur in

the current disturbed area. In general, natural soils in the area are somewhat alkaline, with a pH ranging from 7.2 to 7.8, but contaminants at the site have made the soils acidic in places (pH of 4.9). Applications of lime in amounts recommended by the Soil Conservation Service to those areas with low pH will improve surface soil conditions. This alternative calls for revegetation to improve erosion control, but lack of topsoil at the site may make revegetation difficult.

Raising the pH of affected areas and revegetating may help restore the site to its normal appearance, but hazardous wastes will still be present. Since this alternative does not require fencing the site, the direct-contact exposure route will still be active.

Ground Water

This alternative will result in some leaching of contaminants, thus permitting horizontal dispersal over a period of years. The suspected mechanism for this dispersal is the weathered shale, but the rate of dispersal is not known. Shallow ground-water that outcrops as surface seeps from recent regrading of surface soil will be contained by the catchment ditch.

This alternative will not alter the quantity or direction of ground-water flow. The impact on the quality of the shallow ground-water should be limited to the immediate site area, and the limited quantity of such water significantly reduces the importance of this impact. The underlying shale bedrock is relatively impermeable and should retard pollution of the deep saline limestone aquifer which underlies the shale.

Surface Water

The surface waters potentially affected by contaminants migrating from the A. L. Taylor site are Wilson Creek, Pond Creek, and perhaps the Ohio River. Typical fluctuations, such as heavy discharge following a rainfall, will continue to be materially reduced by manmade controls. The treatment plant will have a steady discharge of about 40 gpm when the plant is operating; however, the plant will operate 3 to 4 days per week. This action should increase minimum flows and reduce peak flows in Wilson Creek.

The quantity of surface runoff eventually entering Wilson Creek should be reduced when the area is revegetated because of the holding capacity of root networks, transpiration, and increased vegetative surface area promoting more evaporation. The runoff caused by a rainfall can be reduced by about 50 percent from a barren clay land surface to a densely vegetated land surface (Seelye, 1960).

The degree of effectiveness of the existing treatment system at the site was discussed in Section 6.1.2. EPA contractor Resources Recycling Technologies, Inc., states that the concentrations of contaminants remaining in the treated effluent discharged to Wilson Creek do not pose a threat to environmental quality (RRT, 1982). However, some demand will be placed on the oxygen resources of the creek by the COD in the effluent.

The water column of Wilson Creek has been sampled once for chemical constituents. Organic compounds in low concentrations were identified as chemicals that were from the site (EPA, 1980). Since this 1979 sampling, all drums stored on the surface have been removed. Because Wilson Creek has not been sampled since, it is impossible to evaluate the current surface water quality and assess impacts of the minimum action alternative.

Wilson Creek sediments contain heavy metals that have either precipitated out of the water phase or been transported into the creek sediments through erosion of contaminated soil. These metals will remain in the sediments, but whether the concentration will increase or not is a question deserving further study.

Terrestrial Biology

Revegetation of the A. L. Taylor site under this alternative will have a positive impact on local terrestrial biota. This alternative will not completely restore the site to its original state, yet the resultant open field will provide a food and nutrient source currently not available. The establishment of grasses over the cleared acreage will supply basic energy and food for herbivores, and the land will once again become productive in the food chain. As herbivores move into this area, predators of higher trophic levels will resume activity in this territory, and eventually a stable community will be established.

The minor excavation and regrading of the onsite pit and surface dumping area located on the wooded fringe of the site will impose a short-term negative impact on local biota. The remedial work at the site will temporarily displace surrounding wildlife largely because of increased noise levels. Excavating soil from the 500-square-foot offsite area in the forested zone will cause a greater temporary disturbance than the onsite activity. Nevertheless, the duration is expected to be very short, and the final plan for these areas is to backfill and revegetate. The long-term impact should therefore be beneficial to terrestrial biota through establishment of a food source and elimination of chemical contaminants that are potentially harmful to wildlife due to direct exposure or ingestion.

One concern is that contaminated surficial soils may remain onsite. Should this be the case, terrestrial biota will be threatened by the presence of these chemicals. Plants and burrowing animals would be the most susceptible to exposure to these chemicals. If the contaminants work their way into the food chain, there is a potential for chronic exposure of a greater number of species over a larger range. The likelihood of this impact is extremely difficult to project. Background data on the existing soil contamination is not very thorough, and the scientific evidence of following each of the contaminants through the food web is still being developed.

Aquatic Biology

There will be some indirect impacts on the aquatic system in Wilson Creek from this alternative. The excavation and minor regrading of the onsite pit and surface spill area may increase siltation and turbidity in the stream. These increases could bury benthic and other bottom-dwelling organisms as well as stress species physiologically intolerant of high turbidity concentrations. However, mitigative measures for runoff control during this earth-moving have been incorporated in this alternative, and this short-term impact is expected to be insignificant.

Properly managed revegetation of the site should be beneficial to the aquatic biota of Wilson Creek over the long term. Applying the fertilizer to the site should be planned at a time when heavy rainfall is

unlikely; otherwise, site runoff containing high levels of nutrients could wash into the creek. Algal blooms would be encouraged in segments of the stream receiving plenty of sunshine along with such a high nutrient loading. If the condition lasted long enough, the algae could eventually make the aquatic system eutrophic and significantly change the characteristics of Wilson Creek. The impact of successful revegetation, when conducted properly, is beneficial because the established field grasses will gradually provide a constant level of organic nutrients to the aquatic system following normal rainfall.

With the operation of the treatment plant, low-level contamination of waterways adjacent to the site will continue. Many of the substances present in water and soil samples taken at the site are known to be directly toxic to aquatic organisms: napthalene, pentachlorophenol, phenol, benzene, toluene, etc. (Wilber, 1969). Several compounds found here (PCBs, lead, cadmium, beryllium, thallium, chromium) tend to bioaccumulate in aquatic organisms (Reid and Wood, 1976; EPA, 1980).

Sampling in 1979 has shown that very low concentrations of PCBs are present in small fish and crayfish downstream from the site (Hines, 1979). The cleanup actions taken since 1979 are believed to have removed the major onsite sources of PCBs and other compounds known to bioaccumulate. Nevertheless, the composition of the remaining subsurface waste is unknown, and it is possible that these same chemicals will be dispersed from the site through leachate. The existing treatment system is designed to remove these contaminants from all the collected leachate and surface runoff. Previous incidents have occurred, however, when the detention lagoon could not hold the quantity of water leaving the site and the lagoon overflowed, releasing untreated wastewater directly into Wilson Creek. Therefore, Wilson Creek is still threatened by chemical contaminants directly entering its aquatic system.

The treatment plant is estimated to discharge 40 gpm 3 to 4 days per week. The effluent will be released continously over 24 hours. The effects of this cyclic discharge into Wilson Creek have not been quantitatively documented since the plant's startup in 1979. One EPA report stated that no aquatic life could be seen over an approximate 20-yard distance downstream from the outfall (Antley, 1979). Although no

sampling has been conducted, it is possible that the treatment system is placing stress on the aquatic system based on the elevated COD levels known to be in the effluent. The cyclic discharge may displace organisms downstream because of the sudden shock of the released effluent.

When the treatment plant is removed in 5 years, the site runoff will discharge into Wilson Creek. The quality of this runoff cannot be estimated, but some reduction in surface soil concentrations from 1981 levels should have occurred due to leaching. Therefore, Wilson Creek may continue to receive pollution from the A. L. Taylor site, but the significance of this impact cannot be accurately assessed.

Threatened and Endangered Species

The site modifications resulting from the minimum action alternative will not directly impact threatened and endangered species whose range includes the project area. The bald eagle and arctic peregrine falcon are primarily visitors to the area and therefore would not be affected by this project. The Indiana bat is known to reside in summer along Knob Creek in northwestern Bullitt County. The reach of the stream where the colony was identified has a rocky substrate and a relatively well-developed riparian zone. Agricultural development was nearby on each side of the stream (Kessler, 1981). The Taylor site project area includes similar habitats, but this alternative does not require further human encroachment into these areas. However, the continued release of chemical contaminants into the food chain following implementation of the minimum action alternative is an environmental threat to all biota, including protected species.

Socioeconomics and Land Use

The minimum action alternative will have no significant impact on the socioeconomic status of the northern portion of Bullitt County. Much of the area surrounding the A. L. Taylor site has been classified as undevelopable land, largely because of topographic features. The existence of the site for the past 14 years has already influenced growth in the immediate area around the site. The number of homes located on

Letts Road, which runs along the southern border of the site, has remained constant for the past 11 years (Aton, 1982). These five modest houses are spread out along a half-mile distance, and it is not known whether local property owners are amenable to further growth in this area. area. In the past, the unsightliness and strong odors of the site and emotional stress have probably deterred new residents from selecting this neighborhood for a homesite. Since the surficial drummed waste was removed in late 1981, much of the odor problem has reportedly been eliminated, and socioeconomic impact has been lessened as a result. No additional socioeconomic impact will result from leaving the hazardous waste at the site.

Implementation of the alternative will employ a very small work force for a short duration. Any future maintenance operations are expected to be the responsibility of one or more government agencies and would not utilize local workers. Because the alternative does not affect the populace in northern Bullitt County, there should be no impact on local or county revenues.

However, implementation of this action would be a formal proclamation that the hazardous waste site exists and will remain isolated from the real estate market as required by federal laws (RCRA and CERCLA). The values of adjacent property likely have been adversely affected by the nuisance presented by the existence of the site. This impact will continue once the public perceives that no further action is to occur on the site.

Under this alternative, future land uses for the A. L. Taylor site itself should be restricted to no more than maintenance of a closed hazardous waste landfill. Observation of soils on the site has shown that chemical contamination still exists. The minimum action alternative includes lime application to these contaminated areas to raise the soil pH to suitable levels for revegetation. This action may enhance the chances for establishing a successful vegetative cover, but lacking further testing, no assurance can be made that phytotoxic hazardous waste does not remain in surficial soils. Also, the lack of a clean soil cover at the A. L. Taylor site will restrict future land uses to prevent direct and indirect human exposure. Agricultural use of the land is not

recommended because of the indirect exposure potential provided by edible crops accumulating toxic chemicals. The same is true for use as grazing farmland. The site should be kept free of deep-rooted vegetative growth so that plants are less likely to uptake any of the chemical wastes. Also, large deep-rooted plants are more likely to cause soil cracks allowing for increased water infiltration and possibly surficial exposure of the hazardous waste.

In summary, the impacts of the minimum action alternative on local socioeconomics and land uses around the A. L. Taylor site are not expected to be dramatic. Assuming that the local residents have understood the historical presence of hazardous waste on this property and that their perception of this alternative is one of basically no change other than aesthetic, then socioeconomic conditions and land uses surrounding the site would be expected to follow the existing trend.

Air Quality and Noise

No historical monitoring of air quality or noise levels has been made at the A. L. Taylor site. The only indicators of air pollution have been odor complaints by site neighbors and possible vegetation stress, but the 1981 removal of drummed waste should greatly reduce odors from the site. Regional air quality is generally satisfactory.

No significant air quality impact is anticipated from the site over the 1981 post-cleanup baseline conditions. Some wind erosion of dry surface soils will occur until revegetation is complete. Furthermore, dust generated by short-term construction can be controlled by the application of water. Fumes and gases will continue to be emitted from the site at current levels, with a gradual reduction over the long term as the reservoir of volatile organic compounds is depleted.

Noise impacts from the site will be short term in nature resulting from construction activity. The periods of interest will be during excavation of the open pit and surface dumping area and during the treatment plant removal 5 years after implementation of the alternative. These impacts should be nondisruptive because they will be carried out during daylight hours, last only 2 or 3 days, and will be more than 500 feet from adjacent residences.

6.1.4 Cost Analysis

The cost analysis of the minimum action alternative is broken into three elements. The construction costs are the near-term costs associated with removing surface contamination. The operation and maintenance costs represent ongoing costs over several years of the project. The life cycle cost presents both construction and operation and maintenance costs for the project in terms of the total present worth for comparison between alternatives.

Construction Costs

The estimated construction cost for each item included in this alternative is shown on Table 6-4. Both a high and low cost estimate are given as appropriate. Labor and material costs are consistent with prevailing wages and the market condition in Louisville in 1981. No new construction is included for the water treatment facilities, but some modifications to the existing system are recommended (see Table 6-3).

The revegetation costs were provided by the U.S. Department of Agriculture, Soil Conservation Service. Only those costs incurred one time are included as construction costs.

The cost estimate for monitoring wells is based on four 15-foot-deep small-diameter wells. They will be constructed according to EPA standards including all stainless-steel screen and casing as described in Section 5.

Operation and Maintenance Costs

Table 6-5 presents the estimated first-year operation and maintenance costs for this alternative. The primary cost of operating the existing water treatment facilities is for activated carbon replacement or regeneration. The costs shown on Table 6-5 were based on the replacement of the entire carbon bed (approximately 13,000 pounds) either one or three times per year. The system has not operated long enough or been sampled often enough to accurately estimate carbon replacement requirements. These estimates assumed a total flow of 5.86 million gallons per year with an influent COD of 700 mg/l while achieving a 50 percent COD removal rate in the carbon unit. This cost also

TABLE 6-4

CONSTRUCTION COST ESTIMATE FOR THE MINIMUM ACTION ALTERNATIVE

ITEM	COST, THOUSAND DOLLARS LOWER	UPPER
Wastewater Treatment[1]	None	
Pit and Surface Dumping		
Excavation & Backfill	12.6	18.9
Transport and Disposal	51.7	79.5
Site rehabilitation (Minor grading, fertilizing, trees, seeding and mulching)	4.0	5.0
Monitoring Wells	10.5	10.5
Security & Safety, Plat Survey & Legal Fees	2.0	3.0
Warning Signs	.1	.1
TOTAL	80.9	117.0

1. No construction costs are included in this alternative, but some modification of the existing system is recommended (see Section 6.1.2)

TABLE 6-5

FIRST-YEAR OPERATION AND MAINTENANCE COST
ESTIMATE FOR THE MINIMUM ACTION ALTERNATIVE

ITEM	COST, THOUSAND DOLLARS LOWER	UPPER
Wastewater Treatment[1]		
Carbon replacement[2]	18.0	43.2
Alum[3]	.4	.9
Power	.1	.1
Labor	2.2	3.4
Sampling & Analysis	2.1	3.0
Repairs	1.0	3.0
Spares and Contingencies	3.0	5.0
Site Maintenance (Mowing, fertilizing and seeding)	3.0	4.0
Ground Water Monitoring[4] Sampling & Analysis	8.2	16.5
TOTAL	38.0	79.1

1. Required for 5-year service life of facilities only.
2. Labor costs are included for work required to complete each item.
3. No chemical additives are presently being used.
4. Required for entire 30-year post-closure period.

includes labor required for replacement. Other operation and maintenance costs for the treatment system were either computed using actual contractor prices or estimated with the help of State personnel presently operating the facility. Labor costs are estimated using Kentucky agency pay scales.

At the end of the fifth year, the treatment plant will be removed and an outfall installed in the catchment pond dike for an estimated $4,000 (1981 dollars). The high cost estimate in Table 6-5 for ground-water monitoring is based on quarterly sampling which will be necessary the first year, while the low cost is for semi-annual sampling and analysis. These costs include the sampling labor, shipping charges and laboratory analyses and will continue for the 30-year post-closure period.

Life Cycle Costs

The life cycle cost of the minimum action alternative will range from an estimated minimum of $435,000 to an estimated maximum of $739,000 as measured in 1981 dollars. The costs were calculated over the 30-year project life in accordance with RCRA closure guidelines. Operation and maintenance costs were compiled over the 30-year period, and the present worth in 1981 dollars was calculated. For this calculation it was also assumed that the water treatment facility would be operated and maintained in its present configuration for 5 years. At the end of the fifth year it would have a salvage value of $8,000. The construction costs are already in 1981 dollars and therefore remain unchanged. The present worth calculations were based on a 10 percent annual inflation rate and a 12 percent annual cost of money.

6.2 ONSITE CONTAINMENT ALTERNATIVE

The basic idea behind the onsite containment alternative is to isolate the buried hazardous waste without disturbing the existing waste cells. The RCRA regulations governing a hazardous waste landfill will be used as guidelines where possible.

Ideally, a hazardous waste landfill would be located where the ground-water table is deep and where the site soil is a clay with a very low permeability to restrict migration of contaminants. The landfill would be located away from areas of dense population, but would have good vehicular access. The wastes accepted at the landfill would be fully categorized and segregated to prevent interaction of incompatible wastes. Finally, the engineering controls would be constructed before any waste is ever placed in the landfill.

The situation is entirely different at the A. L. Taylor site since the waste is already in place and the engineering controls must be constructed around the waste cells. The ground water in the area is relatively close to the surface (5 to 10 feet below land surface) and must be diverted away from the waste. The existing soil at the Taylor site is a suitable clay with low permeability. Since the existing buried waste will not be removed, there will be no engineered liner under the waste cell. Also, the leachate and gas collection system must weave around the existing waste cells rather than having a system of evenly spaced parallel laterals under the waste cells.

The onsite containment alternative does offer an effective method of preventing the waste from spreading by isolating it in a controlled cell. The methods selected to accomplish this goal are outlined in this section and shown on Figure 6-2.

6.2.1 Alternative Description

The detailed description of the onsite containment alternative is presented below in the following sections: (1) slurry wall and bedrock, (2) clay soil cover, (3) leachate/gas collection system, (4) leachate treatment system, (5) runoff/drainage diversion, (6) revegetation, (7) security fence and sign, and (8) record plat.

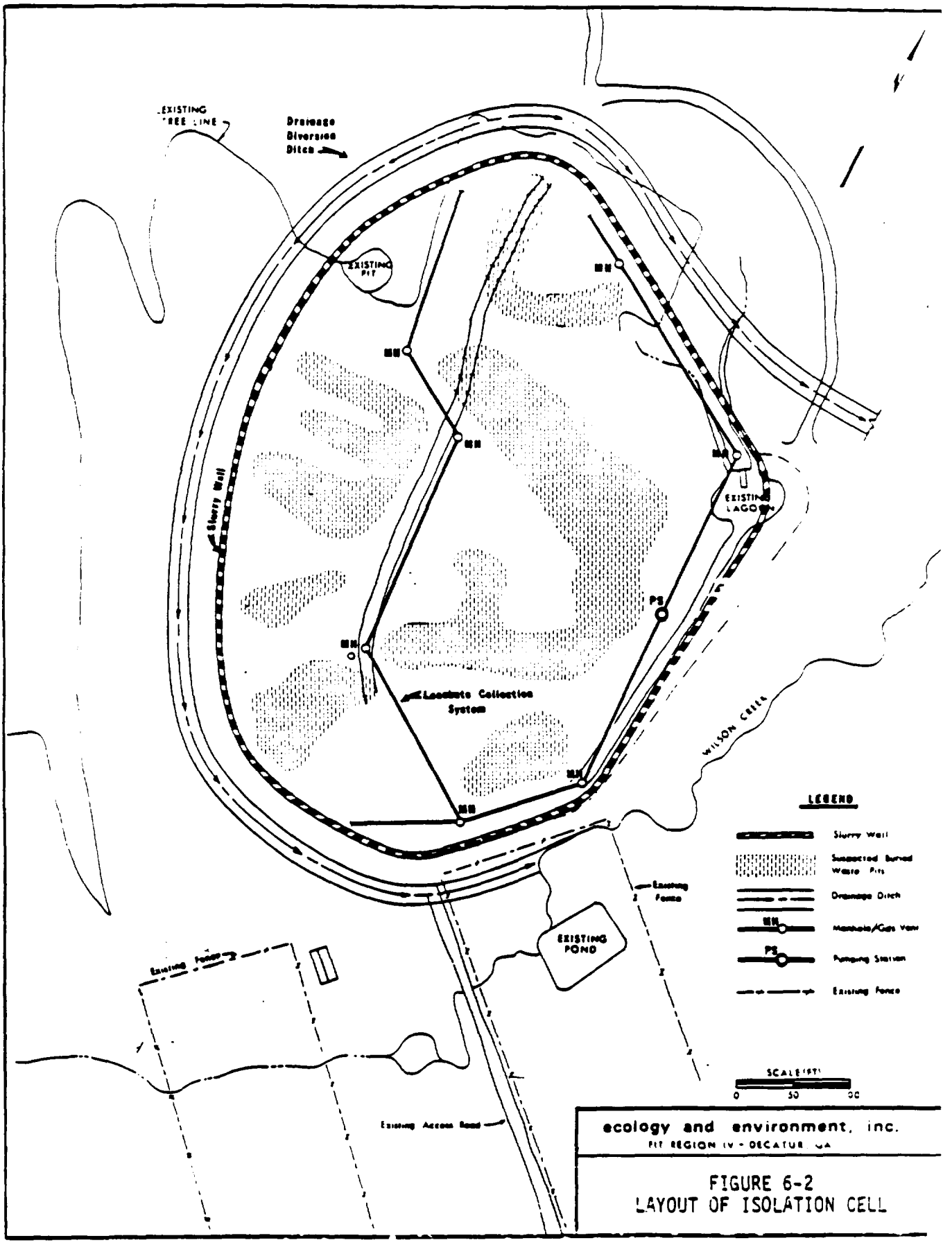

FIGURE 6-2
LAYOUT OF ISOLATION CELL

Slurry Wall and Bedrock

A hazardous waste landfill would normally include an impermeable liner at the bottom and on all sides of the waste cell. However, since the buried waste at the A. L. Taylor site should not be disturbed during construction, the design and placement of acceptable containment will require some improvisation.

As mentioned earlier, the shallow ground-water at the Taylor site is near the surface; therefore, the wastes must be isolated from contact with the ground water. The proposed landfill design will accomplish this by using the underlying bedrock as the bottom impermeable layer and by constructing a slurry wall around the waste area to prevent ground water from entering the isolation cell.

The geologic data collected at the Taylor site indicate that the bedrock consists of shale with minor fracturing. The depth to bedrock under the buried waste is approximately 15 feet. Since the shale is relatively impermeable, it should provide the proposed landfill isolation cell with a good impermeable bottom liner to prevent downward waste migration from the cell.

A slurry wall will provide the impermeable barrier from the ground surface to the bedrock. It will be approximately 1,750 linear feet and will completely surround the buried waste cells. The slurry wall will enclose an area of approximately 4.7 acres if placed as shown in Figure 6-2. It will be constructed by excavating a narrow trench filled with a bentonite slurry to prevent the trench walls from collapsing. The trench is then backfilled with an impermeable material. The slurry wall must be keyed into the bedrock to prevent seepage under the wall and into the weathered shale layer.

The permeability of a slurry wall would only be approximately 10^{-7} cm/sec. Table 4-1 shows that permeabilities of the three soil borings from the site range from 10^{-7} to 10^{-8} cm/sec. In spite of this, a slurry wall is necessary for a number of reasons. First of all, the soil is not homogeneous from the surface down to the consolidated shale bedrock. Secondly, the consolidated shale is covered with a layer of weathered shale in many areas. Unlike the clay, which exhibits extremely low permeabilities, this weathered shale is relatively

permeable. In addition, the soil around the waste cells has been disturbed, whereas the soil data given in Table 4-1 are based on undisturbed soil. An undisturbed soil will generally be less permeable since it has been naturally compacted. Until the soil in the immediate vicinity of each waste cell is fully characterized, it is reasonable to assume that the permeability in the waste area is greater than Table 4-1 suggests.

The existing impermeable clay on the site will aid in restricting ground-water flow, but it cannot be relied upon to do the job alone. Therefore, the installation of a slurry wall around the waste pits will provide a consistent impermeable barrier that extends from the ground surface all the way to the bedrock.

Clay/Soil Cover

The impermeable cover at the proposed Taylor site landfill will consist of a clay/soil admix. The natural clay soils in the vicinity of the landfill have very low permeability and moderate shrink/swell characteristics and will be used for cover material. The thickness of the clay cap will vary across the site to provide a smooth surface; however, a minimum thickness of 18 inches will be maintained. The clay cap will be placed in lifts of not more than 6 inches, with each lift being compacted with a sheepsfoot roller. Further soil testing prior to and during construction should identify the exact compaction effort. The final surface contours of the cap will be sloped to drain.

As can be seen in Figure 6-3, the compacted clay cap will overlap the slurry wall by 12 feet. This will ensure that infiltration will not seep between the slurry wall and the cap. The volume of the compacted clay cap will be approximately 325,000 cubic feet.

A minimum of 18 inches of topsoil will be placed over the clay cap. Once a vegetative cover is established in the topsoil layer, the cap will be protected from erosion, dehydration, and other adverse effects.

Leachate/Gas Collection System

The leachate/gas collection system proposed for the site is shown in Figures 6-2 and 6-4. This system will be constructed prior to

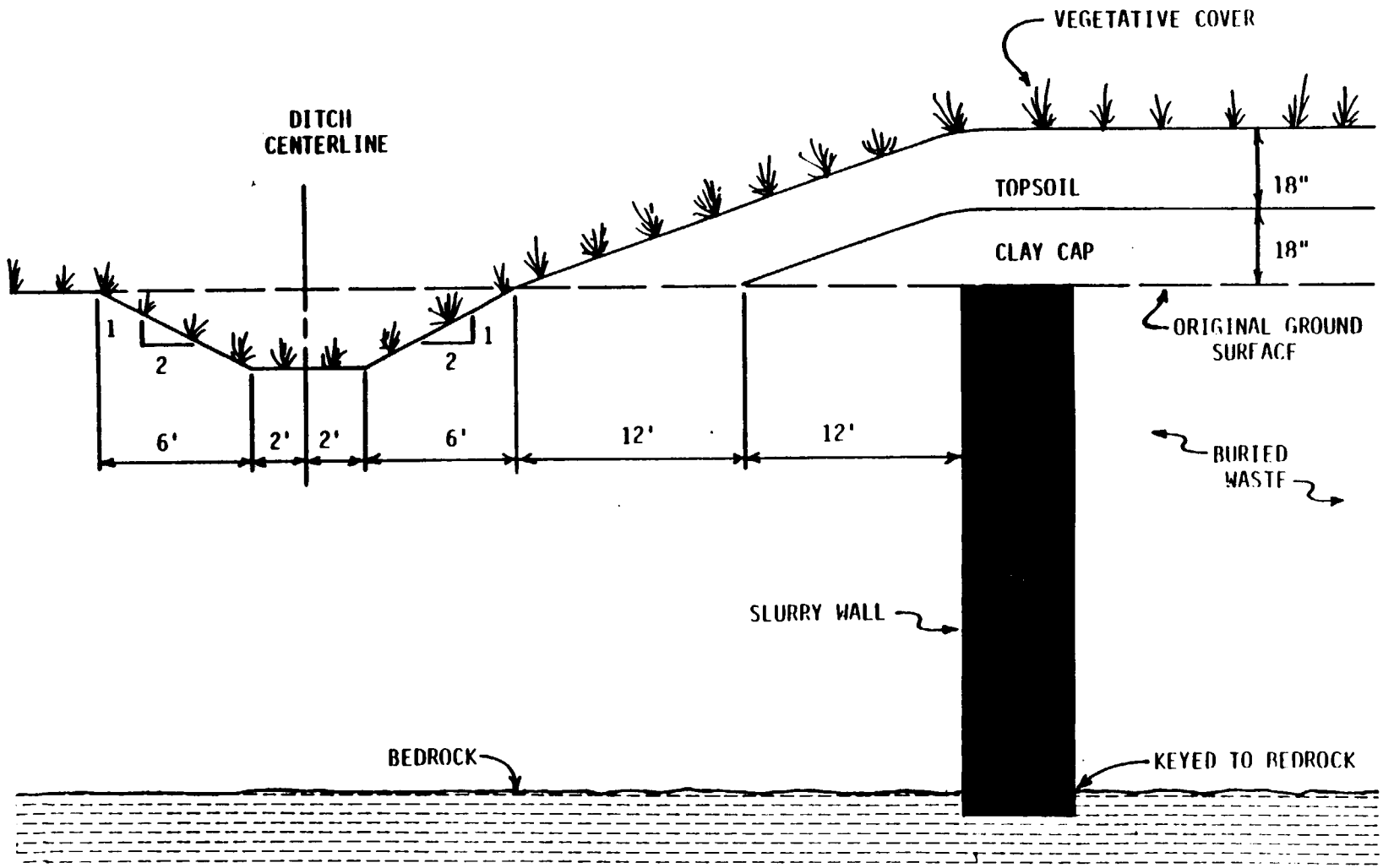

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FIGURE 6-3
TYPICAL CROSS-SECTION OF
SLURRY WALL AND DRAINAGE CHANNEL

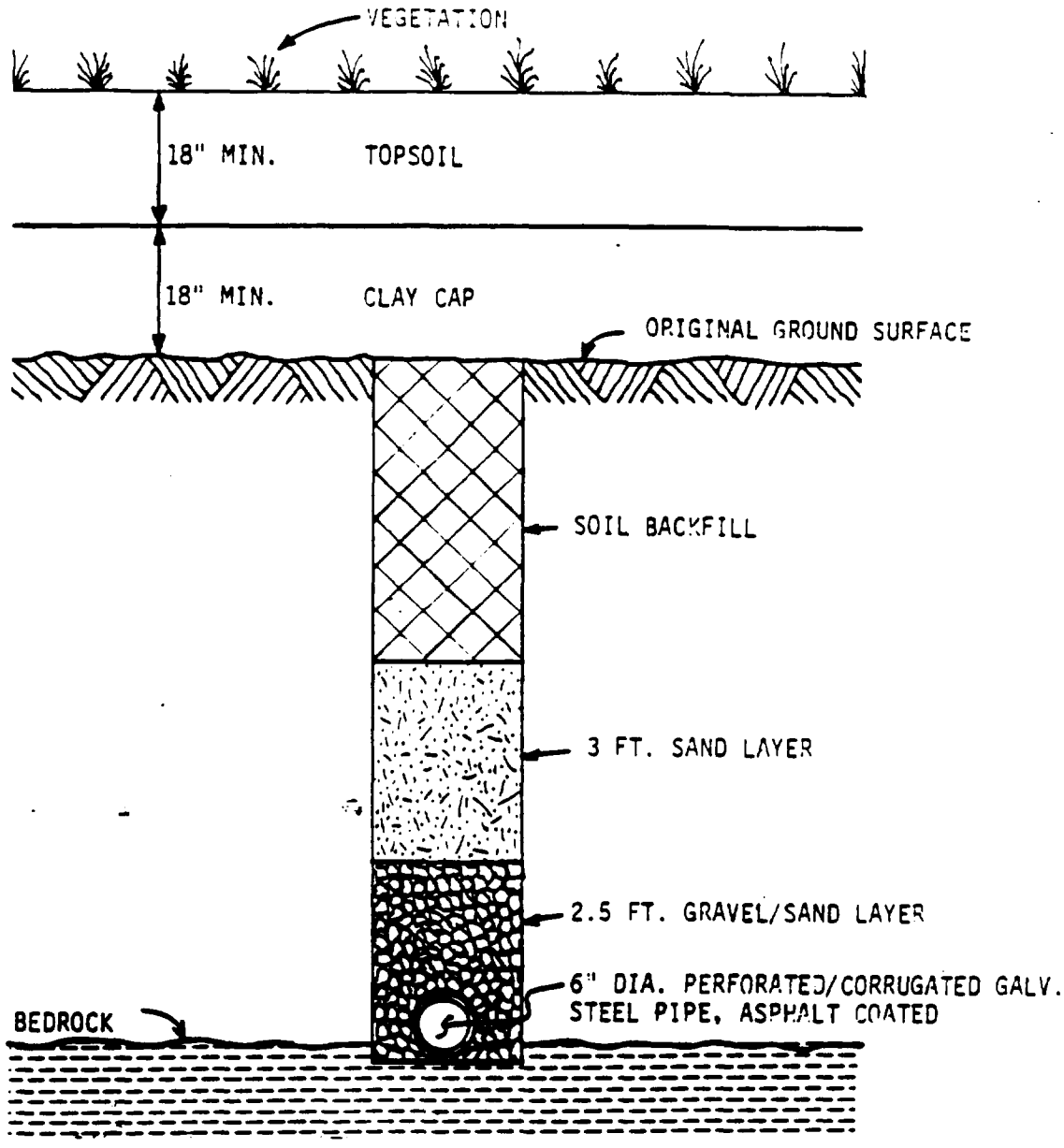

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FIGURE 6-4
TYPICAL CROSS-SECTION OF
LEACHATE COLLECTION TRENCH

installation of the slurry wall or clay cap and will depend on gravity flow to transfer the leachate to the southeast portion of the landfill cell where a small pumping station will pump the leachate to the waste holding tank. As shown on Figure 6-2, there are seven manholes included in the leachate collection system to provide access to the piping for maintenance and to provide a gas treatment/venting system.

The system will be constructed of about 1,400 feet of 6-inch-diameter, perforated, asphalt-coated, corrugated steel pipe (Figure 6-2). As can be seen in Figure 6-4, the pipe will be placed in the bottom of a trench at bedrock level. The pipe will be wrapped in a durable filter screen or cloth that will prevent fine soil from entering the pipe and causing siltation. Two layers of porous material will be placed in the trench before backfilling. A 2-foot gravel-and-sand mixture will be placed over the pipe first, and a 3-foot sand layer will follow. The remainder of the trench will be backfilled with native soil and compacted to prevent settlement.

The slurry wall, clay cap and bedrock will keep significant quantities of gas from migrating out of the landfill cell. The gas that is generated will tend to build up pressure and then begin moving in the path of least resistance. The porous sand and gravel layers in the leachate collection trench offer an outlet for these gases.

The seven manholes and the pumping station will be sealed to keep gases from escaping into the atmosphere untreated. The manholes will be fitted with security locks, and the manholes and the pumping station will be fitted with a pipe vent and an activated carbon cannister to treat and vent the gases. Periodic inspection and replacement of the carbon cannisters will be necessary. The gas vents will also provide a good location for gas sampling and monitoring.

Leachate Treatment

Assuming the engineering controls are installed and maintained properly, very little leachate will be produced in the landfill once the system has reached equilibrium. The leachate collection system will be installed prior to completing the slurry wall so that trapped ground water will have an outlet. After the cell is completely enclosed by the

slurry wall and clay cap, there will be a period of time where the trapped ground water will drain to the leachate system. There will be a greater volume of leachate in the beginning because of this trapped ground water and the moisture from the slurry wall. Over 24 months, the trapped ground water should be slowly removed and the leachate system will reach final equilibrium flow. If additional ground water or rainwater is prevented from entering the cell through the impermeable barriers, the quantity of leachate produced will be minimal. Therefore, leachate generation will have two distinct phases: a high-flow period and a low-flow period.

During the conceptual engineering, the existing treatment plant was planned for use for leachate treatment during the high flow period. Subsequent engineering estimates of leachate generation and disposal and treatment costs indicate that treatment is impractical. Therefore, the treatment plant will be removed and the leachate containerized and hauled offsite for incineration or landfilling. For the purpose of this study, incineration will be assumed. The amount of leachate that will be produced is estimated at between 125 and 875 cubic feet per year.

If the leachate flow rate appears to be excessive after equilibrium has been reached, then the engineering controls may not be preventing infiltration of rainwater or ground water. When this happens, the slurry wall and clay cap must be carefully inspected and analyzed to identify the problem area so that corrective measures can be taken.

Runoff/Drainage Diversion

If runoff from the hill to the northwest of the landfill cell is not properly controlled and diverted around the cell, it could seriously erode the landfill's clay cap and vegetative cover. This runoff will be diverted with a grass-lined trapezoidal-shaped open channel with 2:1 side slopes, a bottom width of 4 feet, and a depth of 3 feet. Velocity-reduction devices will be incorporated into the channel construction to prevent scouring velocities. As shown in Figure 6-2, the proposed drainage channel will divert most of the runoff towards the south and release it to Wilson Creek. However, part of the runoff will enter the ditch, flow around the northern edge of the cell, and enter Wilson Creek farther downstream.

Revegetation

Proper revegetation, site grooming and maintenance are required to ensure the integrity of the engineering controls. The northwest portion of the cell extends beyond the existing tree line and will require some tree removal.

The eroded ditches to the northwest of the cell will be graded and groomed for revegetation. If the initial planting is unsuccessful in some areas, they will receive additional care until a thick vegetative cover is established. The recommended cover is a grass with a shallow root system that will not penetrate the clay cap. A maintenance program including cutting, fertilizing and periodic reseeding will be established and followed carefully. The diversion ditches will be kept free from a buildup of debris or siltation.

Site Security

A chain-link fence will be installed around the entire landfill cell area to prevent public access that could interfere with engineering controls or result in human exposure to contaminants. The fence will be placed approximately 10 feet beyond the outside edge of the drainage diversion channel to allow room for the mowing equipment to operate. A gate large enough for the mowing vehicles to enter the cell area will be installed in the fence at the access road. Several permanent warning signs will be placed along the fence and on the gate, and the gate will be kept locked at all times unless authorized personnel are on the site.

Record Plat

The final step in the site closure will be to document the location and site history. The site will be surveyed and a record plat prepared which will have a warning statement about the wastes that are buried onsite, the location of the waste cells, and a caution statement concerning future use of this land. The plat will be filed in the public records of Bullitt County.

6.2.2 Alternative Evaluation

If the proposed onsite containment measures are properly installed and carefully maintained over the years, the wastes will be prevented

from migrating from the isolated cell area. The following discussion evaluates the overall feasibility and long-term effectiveness of the onsite containment alternative.

Environmental Protection

The onsite containment alternative will provide effective long-term environmental protection from migration of contaminants as long as the site is regularly inspected and maintained. The importance of careful maintenance in this alternative cannot be overstated.

The air quality in the vicinity of the site should improve once the construction process is completed and all engineering controls are in place. Since the waste cells will not be disturbed during construction, an increase in the release of volatile organics is unlikely during construction. There will no longer be any contaminants exposed to the atmosphere. All gases generated in the landfill will be treated before being released to the atmosphere.

The existing surface water collection and treatment system will be utilized during portions of the construction process, but the system will be phased out when construction of the cap is started. A combination of site grading, site grooming, revegetation, and well-maintained drainage channels will ensure that the rainwater runoff is controlled and prevented from generating leachate.

Although the ground water will be diverted around the waste cell, the overall hydrologic effect of this diversion is insignificant. The ground water moves slowly through the area, and the diversion wall will not measurably change the overall direction or rate of ground-water flow. The leachate collection system will prevent a buildup of leachate in the bottom of the isolation cell and thus eliminate the mechanism for leachate to infiltrate the fractures in the underlying shale bedrock.

Reliability

The reliability of the onsite containment alternative depends directly upon how carefully the engineering controls are installed and maintained. If the controls are improperly installed or allowed to

deteriorate, the reliability of this alternative will be substantially reduced.

Landfills are a method of controlling contaminants rather than eliminating them. Other disposal techniques such as incineration or neutralization are usually preferred since they permanently eliminate the hazard.

Implementability

Since the technology and construction methods proposed for the onsite containment alternative are straightforward, there are no physical constraints that would prevent implementation of this alternative. Potential legal constraints do exist. The land is held in private ownership, and the owner may resist having the site perpetually committed to a hazardous waste facility. The Taylors have previously placed a condition on the EPA that the site not be fenced. Furthermore, the question of proper zoning must be explored. Local opposition may persist to the continued use of the site as a hazardous waste facility. The applicability of RCRA permitting to the substantial modification of this site has not been determined. Finally, the State of Kentucky may not be willing to assume permanent responsibility for the maintenance of the facility as required by CERCLA.

RCRA Conformance

The engineering design proposed for this alternative basically follows the hazardous waste landfill criteria outlined in RCRA. Except for the lack of an engineered bottom liner, this alternative is as effective as a new RCRA facility.

Safety

Constructing the onsite containment alternative does present some degree of risk for workers to chemical exposure, fire, and explosion. Accidental disturbance of the buried waste during trench excavation is a distinct possibility. Careful construction practices and onsite fire control equipment will help reduce the hazard of fires and explosions. Air monitoring will characterize the risks presented by the release of trapped gases during construction, and construction workers will be

provided appropriate respiratory protection in the event of such a gas release.

After construction is completed and the engineering controls are in place, the major safety risk is handling the leachate. Proper care and safety procedures will substantially reduce this hazard.

Operation and Maintenance

A maintenance and inspection program must be established and followed rigorously to insure the success of this alternative. It will be necessary to maintain the integrity of the engineering controls forever if the contaminants are to be effectively contained. Once the site has been groomed and revegetated, regular mowing and reseeding will be necessary to ensure that a thick vegetative cover is maintained. The fence, gate, signs, drainage ditch and manholes/gas vents must be inspected regularly for damage. The transition zone where the surface runoff channels intersect Wilson Creek must be inspected regularly to identify any deterioration.

The leachate/gas collection and treatment system will require the most attention, though the level required will decrease over time. The activated carbon cannisters used for gas treatment must be inspected and maintained regularly, and periodic carbon replacement will be necessary over the life of the landfill. The pumping station in the leachate collection system must be inspected and maintained regularly, and the pump will require periodic replacement. In addition, the leachate produced will be containerized and removed as necessary to an approved hazardous waste disposal facility.

A periodic ground-water sampling and monitoring program will be established and carried out over the 30-year life of the landfill. Monitoring gas emissions will be performed only during the first year; gas monitoring beyond that period is not anticipated.

6.2.3 Preliminary Environmental Evaluation

Topography

The onsite containment alternative will permanently modify some of the topographic features at the site, but the impact will not be adverse.

The primary change will result from capping the 5-acre zone of subsurface contamination. Conceptual plans for this alternative indicate that the elevation of the cap may be as much as 3 feet above the existing grade in some areas. However, the site will be graded so that drainage will continue to flow into Wilson Creek.

A minor topographic alteration included in the onsite containment alternative will be construction of the rainwater diversion ditch. This surface-water diversion technique will not adversely impact the site's topographic characteristics and should actually eliminate much of the current erosion problems on the northern slopes of the site.

Soils

Onsite containment of wastes will probably have no significant impact on the natural soils in the area. Disturbance due to trenching will be temporary and localized, and capping of the site should not affect soil characteristics such as permeability and chemistry.

Ground Water

Since the alternative will divert ground water around the buried waste, the direction of ground-water flow will be affected, and a dry cell will created. Thus, on a very localized basis, the quantity of ground water will be affected since it is reduced in the containment area and increased in the area immediately surrounding it. The chemistry of the ground water will not be affected, except that by keeping the ground water from contacting the wastes, its quality will improve.

Construction and proper grading of the clay/topsoil cover will result in diversion of most rainwater off the cover. However, a small amount of rainwater may percolate into the cover. This water will be captured in the leachate collection system and thereby keep material from floating to the surface of the waste cell. Furthermore, the leachate collection system will reduce the infiltration pressure of standing liquids on the shale bedrock by drawing off these liquids.

Surface Water

The proposed clay cap, topsoil, and grading and revegetation plan will affect both the quantity and quality of water discharged to Wilson

Creek compared to discharges from the existing wastewater treatment plant. Initially, the runoff will contain high concentrations of suspended solids and nutrients from the construction and revegetation activities. With the establishment of vegetation, the quality of the runoff should be similar to drainage from the rest of the watershed. The flow from the existing treatment plant only 3 to 4 days per week, and on those days that the facility is operating the flow rate is 40 gallons per minute. The flow from the new drainage system will be similar to the runoff hydrograph for the remainder of the Wilson Creek watershed.

With this alternative, the treatment plant will be dismantled and the leachate transported from the site for treatment or disposal. This action should eliminate the hazardous pollutant load on Wilson Creek.

Terrestrial Biology

Capping and revegetation of the site under this alternative will benefit local terrestrial biota by eliminating the means of direct exposure to hazardous waste and creating a productive land surface. The site fencing required by this alternative will prevent large animals from entering. This protection measure will therefore limit the type of communities living on the site and minimize the risk of damaging the cap's integrity. Although the composition of species using the site may be restricted, the land will once again become productive in the food chain through establishment of open-field grasses, which will supply basic energy and food for herbivores.

Implementation of this alternative will also result in two minor detrimental impacts. Temporary wildlife displacement due to the increased noise levels will occur as a short-term impact. Also, because onsite containment requires a peripheral surface-drainage control ditch, as much as 3 to 5 acres of wooded land will be cleared. The drainage diversion ditch will be grassed, and the result is to exchange a climax forested area for a primary grassed zone. Since the amount of land involved in this habitat modification is small, the impact on the overall project area is expected to be minimal.

Aquatic Biology

A temporary increase in stream sedimentation and turbidity would result due to construction of site modifications. These increases could bury benthic and other bottom-dwelling organisms as well as stress species physiologically intolerant to high turbidity. No increase in surface-water contamination from priority pollutants should occur during this period providing that no currently contaminated areas are disturbed. Mitigative measures for runoff control have been incorporated in this alternative, and the short-term impact is expected to be insignificant.

Properly managed revegetation of the site should be beneficial to the aquatic biota of Wilson Creek over the long term. Applying the fertilizer to the site should be planned at a time when heavy rainfall is unlikely; otherwise, site runoff containing high levels of nutrients could wash into the creek. Algal blooms would be encouraged in segments of the stream receiving plenty of sunshine along with such a high nutrient loading. If the condition lasted long enough, the algae could eventually make the aquatic system eutrophic and significantly change the characteristics of Wilson Creek. The impact of successful revegetation, when conducted properly, is beneficial because the established field grasses will gradually provide a constant level of organic nutrients to the aquatic system following normal rainfall.

The onsite containment alternative will use the existing treatment system during the high flow period. As discussed in Section 6.1.3, the treatment system has not always been capable of holding and treating large quantities of surface runoff following heavy rainfall. Under normal operating conditions, the treated effluent still contains low concentrations of chemical contaminants. These negative factors will continue to exist for a limited time with the implementation of this alternative; therefore, the aquatic biota of Wilson Creek will still be threatened. The potential displacement impacts due to the plant's cyclic discharge into Wilson Creek, as discussed in Section 6.1.3, also are applicable to the onsite containment alternative.

The alternative proposes that the treatment system can eventually be dismantled. At the time of the plant's removal, the aquatic environment will incur several short-term impacts as it adapts to the absence of the effluent and cyclic increased flows. The long-term impact is expected to

be significantly beneficial because the aquatic biota would no longer be subjected to exposure to chemical contaminants.

A long-term impact on the aquatic environment from the site modifications is likely to be caused by the diversion ditch confluent to Wilson Creek. This structure may increase turbidity during periods of rain and possibly alter the physical configuration of a small section of the stream. The mitigative measures incorporated in this alternative include building velocity-reduction devices to alleviate scouring and erosion and providing appropriate substrate in the transition zone. The majority of the water is expected to enter the creek on the southern border of the site near the headwaters of the stream. Therefore, the additional water entering at the downstream outfall is not expected to be great. The characteristics of the intermediate stream segment should therefore be minimally altered because the influx of most of the water will originate near the headwaters, similar to present conditions. The physical configuration of the stream will probably be changed at the outfall points from soil transport during periods of heavy rain. The long-term effect of this change should be minimal because the stream will eventually stabilize.

Threatened and Endangered Species

The onsite containment alternative will result in a beneficial, long-term impact on threatened and endangered species whose range includes the project area. The bald eagle and arctic peregrine falcon are primarily visitors to the area and therefore would not be significantly affected by this project. The Indiana bat is known to reside in summer along Knob Creek in northwestern Bullitt County. The reach of the stream where the colony was identified has a rocky substrate and a relatively well-developed riparian zone. Agricultural development was nearby on each side of the stream (Kessler, 1981). The Taylor site project area includes similar habitats, but this alternative does not require further human encroachment into these areas. Also, the environmental enhancement resulting from secure containment of the hazardous waste will remove the threat of food chain uptake by biota, including the protected species.

Socioeconomics and Land Use

Implementation of this alternative would improve socioeconomic and land use options in the area surrounding the site. One of the predominant factors associated with this alternative is the recognition that an uncontrolled hazardous waste site currently exists here. Securing the hazardous waste on the site would relieve some of the emotional stress imposed by its existence.

Implementation of the onsite containment alternative will require a small work force for a period of three months. Hiring local employees for this construction task would offer a slight short-term improvement of the economic status, but this would not be considered a significant impact. Also, this plan of action would not influence population growth because it does not call for a permanent influx of workers. Local businesses may see a slight increase in revenues during the remedial work, but this effect would be of short duration.

The long-term recommendation for excluding this land from residential use should afford no greater impact than what has historically existed. Suitable land for development is limited in this section of Bullitt County, but the site has not been a part of the usable land market for the past 14 years. The aesthetic and health-related improvements resulting from this alternative are likely to increase land values around the site. However, the continued existence of hazardous waste here might counteract this positive change unless the public is made aware of the effectiveness and reliability of onsite containment.

Surrounding land uses are likely to be enhanced indirectly as a result of this alternative. The site improvements may alleviate the public fears, and new residents would be more amenable to selecting this area for a homesite. This alternative would not influence the recreational use of the nearby L&N Golf Course.

6.2.4 Cost Analysis

The cost analysis of the onsite containment alternative consists of three categories: construction costs, operation and maintenance costs, and life cycle costs. The construction costs include installation of all engineering controls, initial site preparation, and project management.

The operation and maintenance costs represent the estimated annual costs involved in operating the landfill for 30 years. The life cycle cost reflects the overall estimated present worth cost of the project shown in 1981 dollars for comparison of the proposed alternatives.

The estimated construction costs are presented in Table 6-6, while the first-year operation and maintenance costs are given in Table 6-7. Each line item is given as a range of cost in 1981 dollars. This cost approach was selected to emphasize that the costs presented are preliminary estimates and are flexible enough to cover the range of level-of-effort. Examples of uncertainties are types and quantities of waste, exact locations of waste, integrity of bedrock, and soil characteristics. Another 20 percent was added to the subtotal to cover any undefined details and contingencies that might arise at a hazardous waste site. The costs shown in the subtotal are generally applicable to standard construction sites.

Construction Costs

The initial construction cost estimate is shown in Table 6-6. The project management, labor and material costs are based upon the same criteria discussed in the excavate-and-relocate alternative (See Section 6.3.4).

The slurry wall cost was estimated based on a total vertical slurry wall surface area of 29,500 square feet.

Since the soil in the vicinity of the A. L. Taylor site is a clay with a very low permeability, the clay cap and topsoil cover layer prices are based on obtaining the material from a borrow pit within 2 miles of the site. Additional dollars were included in the clay cap costing to cover the high level of compaction required.

The cost shown for monitoring wells includes the installation of four wells. The leachate collection system cost includes 1,380 feet of 6-inch-diameter, corrugated galvanized steel underdrain pipe with an asphalt coating. The costs also include the sand and gravel layers, seven manholes with gas vents, a pumping station, 200 feet of pressure pipe and a 500-gallon leachate storage tank. Since the existing waste treatment system will not be used in this alternative, a cost for removal is included.

TABLE 6-6

CONSTRUCTION COST ESTIMATE FOR ONSITE CONTAINMENT ALTERNATIVE

ITEM	COST, THOUSAND DOLLARS LOWER	UPPER
Slurry Wall	70	110
Clay Cap	62	102
Topsoil Cover	60	100
Drainage Diversion Channel	4	7
Monitoring Wells	8	13
Leachate Collection System	43	72
Removal of Existing Treatment Plant	5	6
Site Grooming, Clearing, Grubbing and Initial Revegetation	4	7
Security Fence, Gate, Signs	28	46
Utilities Installation	1	1
Record Plat	3	4
Project Management, Monitoring, Sampling and Permitting	40	60
SUB-TOTAL	328	528
Undefined Details and Contingencies (20%)	66	106
TOTAL	394	634

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TABLE 6-7

FIRST-YEAR OPERATION AND MAINTENANCE COSTS
FOR ONSITE CONTAINMENT ALTERNATIVE

ITEM	COST, THOUSAND DOLLARS LOWER	UPPER
Mowing, Reseeding, Fertilizing and Other Grounds Maintenance Activities	4	6
Grooming and Renovation of Drainage Channel	1	2
Utilities	1	1
Leachate Pump Depreciation	1	2
Leachate Transport & Disposal	3	10
Gas Treatment	2	3
Groundwater Monitoring 4 wells 2 wells	12-6	20 - 10
Gas Monitoring	12	20
SUB-TOTAL	36	64
Undefined Details and Contingencies (20%)	7	13
TOTAL	43	77

The cost shown for the security fence includes 2,300 linear feet of galvanized chain-link fence 6 feet high with one gate and six warning signs. The utilities include electricity and a temporary field telephone. Other minor details that will be required during initial construction should easily be covered in the 20 percent added for "undefined details."

Operation and Maintenance

Table 6-7 shows the estimated annual operation and maintenance costs for the first year, which range from $43,000 to $77,000. Estimates for costs for each subsequent year range from $23,000 to $43,000. The first-year cost includes quarterly sampling of all four ground-water wells and four manholes, while each additional year includes semi-annual sampling of all four ground-water wells and one annual gas sample.

The importance of maintaining the vegetative cover and keeping the site well groomed in this alternative was discussed previously. For this reason, the annual maintenance cost remains fairly high for the entire 30 years. An annual operation and maintenance cost is also included for grooming and renovating the drainage channel since this structure must be maintained for erosion control.

The annual cost for utilities covers the electricity required to operate the leachate pump. An annual cost for pump depreciation, maintenance and periodic replacement is also included. The amount of leachate expected ranges from a minimum of 62 drums per year to a maxmimum of 186 drums per year. The leachate disposal cost shown includes periodic removal of the drums and disposal at an approved RCRA facility. The annual cost shown for gas treatment covers replacement of the activated carbon cannisters approximately once a year.

Life Cycle Cost

The life cycle cost of the onsite containment alternative will range from an estimated minimum of $939,000 to an estimated maximum of $1,655,000 as measured in 1981 dollars. The costs were calculated over the 30-year project life in accordance with RCRA closure guidelines. Operation and maintenance costs were compiled over the 30-year period,

and the present worth in 1981 dollars was calculated. The construction costs are already in 1981 dollars and therefore remain unchanged. The present worth calculations were based on a 10 percent annual inflation rate and a 12 percent annual cost of money.

6.3 EXCAVATE-AND-RELOCATE ALTERNATIVE

This alternative includes excavating cost of the onsite contamination, transporting it to an approved facility, and restoring the site. This alternative will be the most effective in controlling long-term pollution levels at the site. The cost of this approach is strongly dependent distances to the ultimate disposal site.

6.3.1 Alternative Description

This alternative will remove the contaminated materials from the waste cells, the surface dumping area, and the open pit (Figure 1-2). The buried waste will be excavated, loaded on trucks and transported to an approved disposal site. The extent of excavation will be determined by the monitoring of soil contamination levels. The trenches will be backfilled as the excavation proceeds. After the wastes have been removed and the trenches backfilled, the site will be regraded. Three inches of topsoil will be spread over the disturbed area to facilitate revegetation, and best management practices in erosion control will be implemented. A plat will be prepared from a survey of the site and recorded in the public records of Bullitt County indicating this is a rehabilitated hazardous waste site.

The implementation of these steps should restore the site to normal use. Acceptable future land use would include pasture, woodlands, and non-food agriculture. After some years to allow for natural soil compaction, this site would be suitable for building construction.

Quantity of Wastes

The amount of contaminated material which must be removed is the primary factor in this alternative. Two estimates of the volume of contaminated wastes are presented in Section 1. The lower estimate of 12,500 cubic yards is based on TECHNOS' geophysical work performed before the drums were removed (TECHNOS, 1981). E & E resurveyed the site after drum removal to confirm TECHNOS' estimates. With the site cleared and graded, the E & E survey could investigate areas inaccessible to TECHNOS. The E & E study identified larger cells of buried wastes and estimated up to 31,700 cubic yards of materials must be removed (E & E, 1982). This total volume includes the buried materials from the underground waste

cells, the material in the exposed open pit on the north-central portion of the site, and the surface soils from the dumping area with dead trees northeast of the wastewater treatment plant.

Excavation

The cleanup activities will be accomplished using standard construction practices. The work may proceed considerably slower than normal excavation because of the buried drums. The unit excavation crew will consist of one 1.5-cubic-yard backhoe, one drum grappler, one 3-cubic-yard front-end loader, twenty 28-cubic-yard dump trucks and one semi-trailer trucks. Table 6-8 presents the equipment needed to perform the cleanup, while Table 6-9 presents the number of employees required.

The backhoe and grappler will work as a team to remove material from the trench. The drums will be stacked on one side, and contaminated earth will be stockpiled on the other. The front-end loader will then transfer the contaminated soils to dump trucks for transport, while the grappler will load the drums onto a semi-trailer for removal. Dikes and diversion ditches will be constructed daily to divert surface runoff away from working areas, while water and chemical wastes which collect in the open work pits will be drummed or pumped to the wastewater treatment plant, depending on the level of contamination.

A representative sampling of each waste cell will be performed in advance of excavation and EPA tests performed to determine indicator contaminants. Excavation will continue on each cell until a predetermined acceptable level of soil contamination is reached. A mobile chemistry laboratory outfitted with test equipment to measure the indicator contaminants will be used onsite for measuring levels of soil and water contamination. Field laboratories are available from contractors with a range of capabilities including gas-chromatography/mass-spectroscopy.

Each excavation crew will remove about 500 cubic yards of material per day. This removal rate is only 25 percent of an average daily excavation rate for a similar crew working in clay soils (McMahon, 1981). The reduced capacity will be the result of interference of drums, construction of water diversion structures, and removal of excavation pit

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TABLE 6-8

CLEANUP EQUIPMENT REQUIRED FOR THE EXCAVATE-AND-RELOCATE ALTERNATIVE

TYPE	NUMBER
Management Trailer	1
Mobile Chemistry Lab	1
Backhoe Excavator	2
Backhoe Grappler	2
Front-end Loader, Large	1
Front-end Loader, Medium	2
Bulldozer With Sheepsfoot	1
Dump Truck	40
Pickup Truck	2
Water Truck	1
Fire Truck	1
Ambulance	1
Light Tractor With Disk Harrow	1
Semi-Trailer Truck	2

TABLE 6-9

PERSONNEL ESTIMATE FOR CLEANUP DURING THE EXCAVATE-AND-RELOCATE ALTERNATIVE

PERSONNEL	NUMBER
Management	
EPA On-Scene Coordinator	1
Kentucky Inspector	1
Project Engineer	1
Superintendent	1
Administrative Assistant	1
Crew Number 1	
Backhoe Operator	1
Drum Grappler Operator	1
Front-end Loader Operator	1
Laborers	3
Crew Number 2	
Backhoe Operator	1
Drum Grappler Operator	1
Front-end Loader Operator	1
Laborers	3
Backfill Crew	
Front-end Loader Operator	1
Bulldozer Operator	1
Laborer	1
Pollution Control Crew	
Field Chemist	1
Assistant Field Chemist	1
Wastewater Treatment Plant Operator	1
Technicians	2
Laborer	1

liquids. To improve production, two crews will be used to work the site, so that 1,000 cubic yards per day of material will be transported offsite. Since the volume of material ranges from 12,500 to 31,700 cubic yards, the excavation period may last from 13 to 32 day working days.

Backfilling

Backfill for the excavated trenches will come from an offsite borrow pit. Trucks returning from a disposal trip will pick up a load of backfill for the excavated trenches at the nearby brick clay mining area 2 miles northeast of the site. A backfill excavation crew, therefore, will be required to supplement the A. L. Taylor site crews. One large front-end loader will be needed at the borrow pit to load the dump trucks, and a bulldozer with a sheepsfoot roller will be used at the site to assist the front-end loaders in placement and compaction of the backfill. Slightly more backfill will be required than the waste quantity excavated, and the backfilling operation will be 3 days behind the excavation operation.

Transportation

Two modes of transportation were considered for moving the wastes from the site to an approved landfill. The Louisville and Nashville Railroad provided unit costs to transport the waste material from the site to several disposal sites. These costs are substantially higher than trucking costs; therefore, rail transportation was eliminated from further consideration.

Trucks will be the only viable means of shipping the waste from Brooks, Kentucky, to any of the approved landfills in the region. Closed semi-trailer trucks will haul all drummed wastes, while the bulk wastes will be hauled in either 18-cubic-yard single-unit dump trucks or 28-cubic-yard semi-trailer dump trucks fitted with disposable liners. The 28-cubic-yard units will be used for evaluation purposes in this study. The selection of the disposal landfill will be based on the landfill's acceptance of the waste and the disposal fee.

After excavation and backfilling is completed, site closure will consist of removing the treatment plant, backfilling the drainage ditches, regrading and revegetating the site, installing monitoring wells, and preparing and filing a record plat. This phase will continue for about 10 construction days after backfilling is complete. Recording the plat will take about two months, and the monitoring program will continue for 30 years.

The site will be graded to minimize erosion. Terracing will be used on steep slopes to control runoff velocity, and hay-bail fences will also be used to intercept and detain runoff. After grading, the site will be harrowed and seeded using a light tractor and disk harrow. Hydromulching or straw mulching will be used to retain the seed until a vegetative cover is established.

The wastewater treatment plant will be disassembled and removed after the contamination is removed and all wastewater and runoff have been treated. Usable equipment will be sold for salvage and the remainder disposed of properly. The detention lagoon and collection/diversion ditches will be backfilled with the dike materials.

Monitoring wells will be installed between the site and Wilson Creek to determine if residual contamination may be migrating away from the site. Three wells will be drilled downgradient of the site and one well upgradient. These wells will be drilled into the underlying shale beds, and screens will be provided at the level of the weathered shale. The monitoring program will consist of quarterly sampling for the first year followed by semi-annual sampling thereafter.

The final step in site closure will document the location and activities which took place at the A. L. Taylor site. The site will be surveyed and a record plat prepared, with a warning statement to the effect that this was a hazardous waste site, that the wastes have been removed, but that caution should be used when considering appropriate land use. The plat will be filed in the public records of Bullitt County.

Disposal Options

The options considered for ultimate disposal are incineration or landfilling at a secure chemical landfill. In either case,

representative samples will be taken and analyzed to satisfy disposal facility requirements. In the case of incineration, a test burn will be performed and the residue subjected to the EP toxicity test. Non-toxic material will then be disposed of as ordinary fill. Heavy metals concentrations will be low enough to permit this option.

The only suitable incinerator identified is the LWD, Inc., facility in Paducah, Kentucky. The soils would be trucked 240 miles to the LWD site, incinerated, and returned to the A. L. Taylor site as backfill. However, the incineration alternative has been deleted from further consideration because of its high cost (see Table 6-10).

Landfilling will occur outside the State of Kentucky since no facility is available within the State. The landfills presented in Table 6-10 are representative of available facilities. Selection of the landfill for ultimate disposal depends on waste acceptance by the facility, disposal fees, and hauling costs. Final landfill selection will be made during the remedial action design phase.

6.3.2 Alternative Evaluation

The excavate-and-relocate alternative will provide substantial cleanup of the hazardous waste buried at the A. L. Taylor site. The reliability, implementability, RCRA conformance, safety, and operation and maintenance requirements of this alternative are discussed relative to the criteria described in Section 2.

Environmental Protection

This alternative provides long-term protection for the environment in the immediate vicinity of the site. A short-term increase in the release of volatile organic compounds will be created during the excavation period (about 32 days), but this release will be mitigated by engineering controls such as dust suppression by water sprays. Work will be suspended during weather conditions which prevent adequate atmospheric dispersion of hazardous emissions.

Surface water will receive little additional impact compared to the minimum action alternative since the surface-water collection system and treatment plant already at the site will be used during excavation.

TABLE 6-10

ULTIMATE DISPOSAL FACILITIES FOR CONTAMINATED SOILS

LANDFILL	HAUL DISTANCE (one-way miles)	DISPOSAL COST (dollar/yd^3)
B.H.S., Inc. Wright City, Missouri	331	48.90
CECOS Cincinnati, Ohio	136	80.00
Chemical Waste Management Emelle, Alabama	515	50.00
U.S. Ecology Sheffield, Illinois	450	178.00
Adams Center Landfill Ft. Wayne, Indiana	273	40.00
Incinerator		
LWD, Inc. Paduka, Kentucky	240	250.00

Ground water will not be adversely affected by the excavation activities. Backfilling will follow immediately after excavation preventing the creation of large surface impoundments, and furthermore, the backfill material will be similar to the native clays of the site. This will result in no long-term change in the hydrology of the site. The excavation and removal will eliminate most of the surface contamination, thereby protecting the human population and food chain from direct contact with the contaminated soils.

Reliability

On a site-specific basis, this is a reliable alternative. Removing the waste eliminates the reservoir for all phases of environmental pollution. The degree of pollution control will be related to the acceptable level of contamination allowed to remain onsite. Low levels of some contaminants will remain, but these will be set sufficiently low, using best scientific judgement to protect human health and welfare and the environment. For ultimate disposal, landfilling is less reliable than incineration because incineration destroys the waste while landfilling just provides long-term storage.

Implementability

There are no physical constraints to development of this alternative. Excavation and transport of the material can be accomplished using established hazardous waste cleanup practices. The legal constraints on this alternative include acceptance of the waste by the available landfills and the consent of the receiving state's regulatory agency which must approve the disposal. Similar wastes are presently being exported to all the states considered, and no unusual problem is anticipated. This alternative should be the most acceptable to the community near the A. L. Taylor site because it rehabilitates the land and removes the hazard.

RCRA Conformance

This alternative is consistent with the disposal guidelines in RCRA regulations because all wastes will be removed and transported to a RCRA-approved facility.

Safety

This alternative presents some risk for worker exposure, fire, and explosion since unknown materials are being excavated and trapped gases may be released. Monitoring for gas releases will continue during excavation so that worker protection can be assigned. Workers will be provided respiratory protection as appropriate. Fire and explosion can be controlled by proper practices and onsite fire control equipment.

Any spill onsite will be controlled by the existing surface-water containment system. Traffic accidents involving the dump trucks and resulting in a spill are the major risk. This risk is constantly accepted by the population in general and will be mitigated by standard spill response procedures.

Operation and Maintenance

This alternative has very low operation and maintenance requirements, and after the initial revegetation of the regraded site the land can be returned to beneficial uses. The only long-term operation involves the 30-year ground-water monitoring program.

6.3.3 Preliminary Environmental Evaluation

Topography

The long-term topographic impact of the excavate-and-relocate alternative is anticipated to be beneficial. Following the removal of 14 acres of waste and contaminated soil, the site is to be returned to an evenly graded area sloping gently toward Wilson Creek. The steep banks bordering the northwestern edge of the site will be terraced to reduce the erosion potential. This alternative, albeit a long-term modification, would be expected to improve the land's suitability for use by eliminating many of the undesirable land surface features that currently exist.

Soils

This alternative has the greatest short-term impact on soils, since it involves total displacement and replacement. Since replacement will be with a soil of similar properties, there should be no long-term

effects. Replacement soil is to be applied in layers and compacted as the original soil is removed. Minor expansion or settlement will occur after placement, and it will probably take up to 5 years for the soil to assume a natural degree of compaction. Revegetation will protect the soils from erosion.

Ground Water

The quality of ground water in the immediate vicinity will be greatly affected by this alternative. The design calls for collection of contaminants as excavation proceeds, but it may not be possible to capture all contaminated ground water. Escaping ground water may therefore provide a means to transport contaminants away from the site and into the ground-water system at large. This occurrence is a possibility, but migration of significant quantities of contaminants is not likely due to the relative impermeability of the soil and underlying bedrock.

The ground-water flow pattern may be temporarily diverted towards the excavation trenches during soil removal, especially if it becomes necessary to pump leachate or ground water out of the trenches. Even though the trenches will be backfilled and compacted, the fill area may act as a reservoir for ground water until the soils reach a natural degree of compaction. In time, normal flow direction should be established.

The flow rate through the natural clay at the site is slow (0.01 to 0.1 feet per year). Therefore, excessive quantities of ground water collecting during excavation should not be a problem, especially if backfilling is continuous following trenching. Nonetheless, some influx of water can be expected.

Resistivity soundings indicate a fracture or set of fractures in bedrock at about 35 feet below land surface in the west-central portion of the site (Sounding Locations D-9, D-8, F-8 and J-8 on Figure 4-2). This area has had 15 to 20 feet of material removed from it in the past. The shallow fractures may be expansion fractures associated with the unloading, a fairly common phenomena (Hyndman, 1972; Lahee, 1961).

Such fractures generally are nearly horizontal and therefore are not expected to be a pathway for contaminants to penetrate deeper into the earth. The inducement of these fractures over such a short period of time may indicate that it is possible for further fracturing to occur with unloading during excavation. This type of fracturing may result in greater lateral permeability of the rocks underlying the site but should not affect vertical permeability to the underlying saline aquifer. In the long run, the effect of this alternative on both soils and ground water is one of enhancement compared to present conditions.

Surface Water

Surface water and treatment plant effluent will discharge to Wilson Creek during the excavation phase, while the catchment lagoon and treatment plant will capture and treat all runoff during the excavation phase. The discharge during the excavation period should be similar to the discharge from the minimum action alternative. Since the catchment lagoon will be dredged and filled in and the plant removed after excavation, the discharge of small quantities of pollutants from the treatment plant will stop.

When the treatment plant is removed and the catchment lagoon filled, the surface runoff from the rehabilitated site will discharge directly into Wilson Creek. Until vegetation is reestablished, the runoff will have an increase in suspended solids and turbidity. Furthermore, fertilization during revegetation may temporarily increase the nutrient load to Wilson Creek. Best management practices, such as hay-bail fences and mulching, will be applied during the revegetation period to reduce pollution levels. These effects will be heaviest the first year after construction and taper off to background levels by the end of the fifth year.

The short-term effects of this alternative will be increased solids and nutrient load to the Wilson Creek watershed. The long-term effect will be to reduce or eliminate the discharge of hazardous pollutants to Wilson Creek.

Terrestrial Biology

The major excavation and regrading of the disturbed area, including the surface dumping area located in the wooded fringe of the site, will impose a short-term negative impact on local biota. The remedial work at the site will permanently remove existing burrowing organisms that cannot escape for the area. Also, the site work will temporarily displace surrounding wildlife largely because of increased noise levels. The final plan for these areas is to backfill and revegetate. Terrestrial communities will then reestablish themselves at the site, and the long-term impact should be beneficial. Elimination of chemical contaminants on the site will protect local terrestrial biota from further exposure.

Revegetation of the site under this alternative will be a long-term positive impact on terrestrial biota in this area. The establishment of grasses over the cleared acreage will supply basic energy and food for herbivores, and the land will once again become productive in the food chain. As herbivores move into this area, predators of higher trophic levels will resume activity in this territory, and eventually a stable community will be established.

Aquatic Biology

There will be some indirect impacts on the aquatic system in Wilson Creek from this alternative. The excavation and regrading may increase siltation and turbidity in the stream. These increases could bury benthic and other bottom-dwelling organisms as well as stress species physiologically intolerant to high turbidity. However, mitigative measures for runoff control during this earth-moving have been incorporated in this alternative, and this short-term impact should be minimized.

Properly managed revegetation of the site should be beneficial to the aquatic biota of Wilson Creek over the long term. Applying the fertilizer to the site should be planned at a time when heavy rainfall is unlikely; otherwise, site runoff containing high levels of nutrients could wash into the creek. Algal blooms would be encouraged in segments of the stream receiving plenty of sunshine along with such a high nutrient loading. If the condition lasted long enough, the algae could

eventually make the aquatic system eutrophic and significantly change the characteristics of Wilson Creek. The impact of successful revegetation, when conducted properly, is beneficial because the established field grasses will gradually provide a constant level of organic nutrients to the aquatic system following normal rainfall.

The treatment plant will be used during the remedial work at the site, and the impacts associated with this system as discussed in Section 6.1.3 are applicable to this alternative. Once the site is regraded and revegetated, the treatment system will be dismantled and removed. The aquatic environment will then be enhanced by the absence of stream pollutants. Aquatic communities will stabilize to the unstressed environment, and the long-term impact will be significantly beneficial.

Threatened and Endangered Species

The excavate-and-relocate alternative will result in a beneficial, long-term impact on threatened and endangered species whose range includes the project area. The bald eagle and arctic peregrine falcon are primarily visitors to the area and therefore would not be significantly affected by this project. The Indiana bat is known to reside in summer along Knob Creek in northwestern Bullitt County. The reach of the stream where the colony was identified has a rocky substrate and a relatively well-developed riparian zone. Agricultural development was nearby on each side of the stream (Kessler, 1981). The Taylor site project area includes similar habitats but this alternative does not require further human encroachment into these areas. Also, the environmental enhancement resulting from removal of the hazardous waste will eliminate the threat of food chain uptake by biota, including the protected species.

Socioeconomics and Land Use

The excavate-and-relocate alternative will impose both short-term and long-term socioeconomic impacts. This alternative will not require permanent establishment of a work force and therefore would not directly influence population growth. Local businesses may see a slight increase in revenues during the excavation activity, but this effect would be of

short duration. While the site is being excavated, nearby residents are likely to be affected by the noise of the heavy construction equipment and the increased traffic along unimproved Letts Road and the National Turnpike. To mitigate this impact, all site activity should be carried out during reasonable daylight hours. These short-term socioeconomic impacts would not be considered significant.

The major impact of this alternative is the long-term pollution abatement and elimination of a serious health risk. Restoration of the property to a clean expanse of land would allow local residents to relinquish any fear of hazardous waste exposure. Removal of all the wastes will also afford a greater potential for area land values to increase, thereby improving the local economic status.

The future land use options for the property subsequent to this alternative will include forested land, agricultural land (nonedible crops), recreational area and eventually residential land. The land use improvements available to the site are likely to beneficially affect adjacent properties. Since incoming residents would more readily accept purchasing land in the vicinity of the site, a slight boost in local population density may result. The long-term impacts on socioeconomic conditions and land uses as a result of this alternative are therefore favorable.

6.3.4 Cost Analysis

The cost analysis of this alternative is broken into three elements: construction cost, operation and maintenance costs, and life cycle costs. The construction costs are the near-term costs associated with excavating and relocating the wastes. The operation and maintenance costs represent ongoing costs over 30 years of the project, while the life cycle cost presents all costs for the project brought back to the present worth for comparison with other alternatives.

Construction Costs

Construction costs include excavating the wastes, transporting them to an approved disposal facility, and closing the site. Table 6-11 presents the anticipated range of costs in 1981 dollars for this

TABLE 6-11

CONSTRUCTION COST ESTIMATE FOR EXCAVATE-AND-RELOCATE ALTERNATIVE

ITEM	COST, THOUSAND DOLLARS LOWER	UPPER
Agency Management	5	12
Project Management	15	32
Pre-Excavation Sampling and Permitting	29	29
Mobilization	17	17
Excavation	85	204
Backfilling and Topsoil	80	179
Pollution Control	68	151
Closure	29	32
Utilities	1	1
SUB-TOTAL	329	657
Undefined details (10%)	33	66
Contingencies	33	66
SUB-TOTAL	395	789
Transport and Disposal	1,000	3,300
TOTAL	1,395	4,089

alternative. The major cause for the large range of costs is the large range in possible waste amounts to be managed. Agency management costs are estimated base salaries plus fringe benefits (30 percent), while all other labor is provided by the cleanup contractor and includes fringe benefits (30 percent) and overhead and profit (20 percent). Pre-excavation sampling costs include case sampling and analysis needed to thoroughly characterize the buried waste for disposal and selecting indicator compounds used in determining when to stop excavating. Excavation costs include labor, equipment rental, and materials. Labor and equipment and rental rates are typical of the Louisville area in 1981 (McMahon, 1981). Equipment rental rates include fuel, oil and maintenance.

The material costs assumed are for building temporary structures and personnel decontamination facilities. Backfilling costs are on the same basis as excavation but include $2 per cubic yard for the borrow material. The pollution control cost includes the field chemistry laboratory for analysis of soil and water samples and the operating costs of the wastewater treatment plant during the excavation phase. Mobilization is the contractor's cost for starting and closing the job including steam cleaning of the assembled equipment (no teardown is anticipated). Utilities include telephone, trucked-in water, and electricity, while closure costs include removing the treatment plant, regrading the site, mulching, seeding, drilling four monitoring wells, and preparing a record plat.

Contingencies are limited to only 10 percent because a wide range of cost has been established. If a single cost approach directed at estimating the average cost was used, a contingency of plus or minus 50 percent would be appropriate. Undefined details cover items that are too small to have their own line item but cumulatively have a significant cost.

Transport and disposal costs were developed by considering several landfills as disposal sites. These landfills have disposal fees that range from $40 to $178 per cubic yard and one-way haul distances that range from 136 to 515 miles (Table 6-10). Trucking costs also range from $2.65 to $3.05 per loaded mile. These factors, coupled with range in waste volume, lead to the range of costs presented in Table 6-11.

Operation and Maintenance Costs

The operation and maintenance costs are limited in this alternative to grounds maintenance and environmental monitoring. For the first 5 years, the site will be maintained to prevent erosion and insure revegetation. After that no maintenance is planned. The land could be returned to beneficial use, but no credit in the cost of the alternative will be given. The monitoring wells will be sampled four times the first year and semi-annually thereafter. The operation and maintenance costs are summarized in Table 6-12.

Life Cycle Cost

The total life cycle cost of this alternative will range from $1,520,000 to $4,322,000 in 1981 dollars. Life cycle costs are calculated over the 30-year project life in accordance with RCRA closure guidelines. Construction costs are in 1981 dollars and therefore are unchanged. Operation and maintenance costs are compiled for the 30-year period and the present worth calculated. Site rehabilitation will last for 5 years, while monitoring well sampling will last for 30 years. Present worth is determined using a cost escalation rate of 10 percent and an equivalent cost of money of 12 percent.

TABLE 6-12

FIRST-YEAR OPERATION AND MAINTENANCE COST ESTIMATE FOR EXCAVATE-AND-RELOCATE ALTERNATIVE

ITEM	COST, THOUSAND DOLLARS LOWER	UPPER
Monitoring Well Sampling[1]	16	24
Revegetation[2]	3	5
Erosion Control[3]	1	2
TOTAL	20	31

1. Quarterly sampling first year and annual sampling thereafter.
2. In fifth year 100 sapling trees will be planted in addition to mowing and reseeding.
3. Importing soil to fill erosion features.

SECTION 8
RESPONSE TO COMMENTS

This section presents responses to comments made by the Environmental Protection Agency (EPA) and Kentucky Department for Natural Resources and Environmental Protection.

8.1 EPA Comments

The following are responses to comments made by Shane Hitchcock, EPA Project Officer, Emergency and Remedial Response Branch, Site Screening and Engineering Section.

Page 1-8 line 11 — Comment: Is Louisville the correct location for Smith's Landfill?

Response: Change Louisville, Kentucky to Brooks, Kentucky.

Page 1-10 — Comment: Who is the source of Table 1-1.

Response: TECHNOS, Inc. is the source of this table.

Page 1-12 line 3 — Comment: Make the following word change

Response: Delete "are known animal carcinogens" and insert "have been determined to cause cancer in laboratory animals"

line 25 — Comment: Did fish samples taken from Wilson Creek contain PCB's?

Response: Fish and crayfish tissue samples were taken from Wilson Creek and they contained low levels of PCB's. Reference: Memo from Jim Scarbrough, Chief Residuals Management Branch, EPA Region IV, May 2, 1979.

Page 6-5 — Comment: Is twice annual monitoring of the treatment plant sufficient to determine breakthrough of contaminants on the Carbon Treatment process? Should a recharging schedule be developed?

Response: Semi-annual monitoring should be sufficient after a breakthrough study has been completed.
Insert the following sentence between the second and third sentences of the first paragraph under Runoff Collection and Treatment Facility: "An activated carbon recharging schedule for the treatment plant will be developed based on influent and effluent quality and pumping volumes."

Page 6-34 Comment: Explain why hauling offsite is more cost-effective than treating leachate onsite.

Response: The following is an amplication of the reasoning presented in the second paragraph beginning "During the conceptual engineering . . ."

The quantity of leachate generated by the site was estimated. Cost estimates were prepared for two scenarios; (1) treating the estimated volume onsite using the existing treatment plant and (2) containerizing the waste liquids and incinerating them at an approved facility. The second approach was much less expensive and was therefore judged to be more cost-effective. Furthermore, the second approach reduces the likelihood of impacts to the environment resulting from treatment plant malfunction.

Page 6-37 Concern has been expressed that the language of the third paragraph may be constructed to mean the site would become an active facility and receive new wastes. The facility will not receive any new wastes and should be considered inactive. Insert the word "inactive" in line 12 as a modifier to hazardous waste facility. Revise line 15 to read; "to the continuation of the site as an inactive hazardous waste facility."

Page 6-49 Insert "upon" between "dependent" and "distances" in the fifth line of the first paragraph.

Page 6-50 Comment: Drums which have been buried for 4 years will not be in good enough shape to be stacked on a truck. The drum's contents will have to be combined and shipped in bulk. This also will reduce handling and analytical costs.

Response: Insert the following at the end of the third sentence of the third paragraph. If the recovered drums are too deteriorated to be transported directly a batching operation will be initiated. The contents of the drums will be mixed and disposed of in bulk, while the drums will be disposed of separately.

Response to comments made by W. Bowman Crum of the Region IV EIS Branch in a memo to Shane Hitchcock on April 13, 1982.

1. Comment: The development of a No-Federal-Action alternative should be a part of this feasibility study. This alternative appears to be viable at this time since agreement with the State of Kentucky to use Superfund for remedial action has not been worked out and is not assured. The No-Federal-Action alternative should address State responsibilities and likely State action in the absence of Federal funds. Should Superfund be used, the development of this alternative will be helpful in preparation of the environmental assessment.

Response: The minimum action alternative developed in Section 6.1 of the Feasibility Study report is equivalent to a No-Federal-Action alternative requested above.

2. Comment: Difficulties exist in assessing the potential environmental risks presented by the A. L. Taylor site. Areas of uncertainty that remain because of the absence of information include:

   a.) A lack of air quality data from which to assess public health impacts.

   b.) The groundwater contribution to surface water is not known.

   c.) The extent of the groundwater resources is not fully understood.

   d.) Groundwater movement through the weathered shale has not been determined.

   e.) Existing surface water quality is unknown.

   Response:

   a.) The lack of site specific air quality data is of concern regarding assessment of impacts for the minimum action alternative. However, alternatives which include covering or waste removal, should improve the long term air quality. These mitigative acts will be completed for groundwater and surface water protection regardless of air quality. Therefore, air quality data is not of vital concern regarding alternative selection or design.

   b.) As a result of the Remedial Action Site Investigations performed and published in an April 1982 draft report by Ecology & Environment, Inc., a strong connection between surface water and groundwater is not suspected. Shallow groundwater above the shale bedrock occurs mostly as soil moisture. Soil permeability is 10^{-7} centimeters per second or less and no underground drainage flow pattern was detected in the weather shale. The weathered shale occurs 15 feet below the surface between the clay soils and the shale bedrock. The weathered shale is not known to outcrop anywhere along Wilson Creek.

   c.) The soil moisture is not a usable water resource. The shale bedrock yields water at rates insufficient for domestic use and the deep groundwater from the limestone aquifer is reported as being saline. Of these facts only the salinity of the deep aquifer has not been confirmed by either the site neighbors unused water well or borings. Considering the 150 foot thickness of the combined New Albany and New Providence Shales the deep

aquifer does not appear to be threatened. EPA has authorized drilling a deep test well near the site to confirm the integrity of the shale and the deep groundwater quality. Data to be available in December 1982.

d.) Rapid migration through the weathered shale is not suspected because of the low levels of contamination detected in the monitoring well drilled into the weathered shale during the Remedial Action Site Investigation. Also see (b) above.

e.) Surface water quality in Wilson Creek remains an unknown. Sampling of the creek was deleted from the 1981/82 Remedial Action Site Investigation by Region IV, EPA.

3. Comment: More evidence should be provided to support conclusion #5 that some additional data is not justified on the basis of cost and time. How would the obtaining of this data possibly affect the selection of one alternative over another? Could obtaining this data possibly result in an alternative which is less costly and thus results in overall savings? It is clear that additional information on the transmissivity of the weathered shale layer is needed before a determination can be made on the need for a slurry wall in the onsite containment alternative. Most of the report seems to support the need for this wall, however, there is no documentation of the need. We agree with the recommendation for the three additional facts to be documented before a decision on the slurry wall can be made.

   Response: Conclusion number five refers to the alternative selection process and not completion of conceptual design. Furthermore additional data on air quality, surface water quality and groundwater hydrology would not effect the selection decision because both remedial action alternatives intercept all release mechanisms. Therefore, the decision is primarily on cost. The slurry wall is a safety measure and allows evaluation of site security on the basis of a homogenious barrier compared to the vagueness of the disturbed geology of the site.

4. Comment: The need to meet RCRA standards is unclear. RCRA standards are mentioned several times, however, it is not clear if there are requirements that must be met or if these standards are only referred to as guidelines.

   Response: RCRA regulations do not apply to Superfund sites. The standards were used for comparison as a datum for acceptable performance.

5. Comment: Control of release pathways is an objective of this study. It would seem that the understanding of release pathways could be improved with the additional information mentioned above.

Response: True. The additional information, however, would not change decisions on the alternative selection. This information might reduce construction costs of the preferred alternative.

6. Comment: There appears to be several questions concerning implementability which need clarification. Restrictions placed on remedial action alternatives by the owners of the site need explanation. Also, a better indication of the wishes of the public would be helpful.

   Response: Institutional difficulties are the responsibility of the implementing agency. The Role of the Feasibility Study is only to point out these difficulties. None of the difficulties identified in the Feasibility Study would stop remedial action from taking place, only slow the process. A public meeting was held on August 11, 1982 in Frankfort, Kentucky to solicit public input. The public was mostly interested in whether all the wastes would be removed, how much it would cost and what government agency would pay for long term maintenance.

8.2 Kentucky Comments

The following are responses to comments made by Barry Burrus, Chief Uncontrolled Site Sections, Division of Waste Management, Kentucky Department of Natural Resources and Environmental Protection in his letter of May 12, 1982. A copy of the complete letter is included at the end of this section.

1. Comment: None of the three alternatives discussed in the report addresses the problem of the leachate plume coming from the disposal pit which was documented in the Technos report of June 1981 (page 18). Any alternative solution should address this known problem.

   Response: Review of page 18 and the associated report figures of the TECHNOS, Inc. Report of June 1981 does not clearly define a plume separate from the possible geological differences across the site. Therefore, at the time of report preparation this site feature was not considered significant. Furthermore the area in question is covered by the proposed clay cap.

   The Remedial Action Site Investigation, A. L. Taylor Site completed after the Feasibility Study, in April 1982, placed four monitoring wells in the area east of this "plume": K-16, L-14, L-12 and L-11. Of these well holes L-14 and an upgradient Hole H-12 are the most likely to penetrate the "TECHNOS" plume. A groundwater sample from hole L-14 contained toluene (3600 ug/l), ethyl benzene (1500 ug/l) and 1,2-transdichloroethylene (1200 ug/l) and five other organic compounds at concentrations less than 130 ug/l each. Hole H-12 was dry. A soil sample taken from the bottom of Hole H-12 contained five heavy metals (above background levels), cyanide, toluene (190 ug/kg) and ethylbenzene (80 ug/kg).

Although both holes show contamination the fact that H-12 is dry and L-14 is wet indicates "the plume" is not an across site groundwater or leachate feature. The concentrations in L-14 are relatively low (total organics less than 7 ppm) which leads to the conclusion that L-14 is near the limits of contamination. The Clay Cap in the recommended remedial alternative would extend past the location of L-14.

2. Comment: The question of the extent of fracturing in the shale bedrock needs to be resolved.

Response: The feasibility study was completed before the Remedial Action Site Investigation, therefore, the question of fractures in the shale bedrock under the site was left open. The Remedial Investigation concludes that vertical migration through the Shale bedrock to the underlying limestone aquifer was unlikely. This conclusion is based on literature, resistivity sounding, and professional judgement.

The slow migration rate in the soils and weathered shale, indicated by low levels of pollution in Remedial Investigation monitoring well, eliminates concern over migration in the weathered shale zone.

Comment: As discussed with you, Jim, and Al Cherry when you were here, I recommend that a fourth remedial alternative be developed and priced. This alternative would be some combination of alternatives 2 and 3 as given in the report; i.e., there would be some off-site removal of buried hazardous wastes, but some amount of contamination would be left and contained on-site. Based upon our discussions, it appears that this fourth remedial alternative would fit the following guidelines:

a. Cost less than $1,000,000;
b. Include "excavation and removal" in the major disposal pits;
c. O & M would be primarily revegetation and monitoring. There would not be a leachate collection system.

Response: A modified removal alternative was developed in response to this comment. The modified removal alternative was presented to Kentucky personnel on 2 June 1982. A copy of the presentation material is attached in Appendix C. The modified removal alternative was recommended by Kentucky personnel for implementation. Should EPA concur with Kentucky's selection the details of the alternative will be developed and analyzed during the conceptual design. Sufficient information will be developed to substantiate cost effectiveness and environmental protection.

Page 1-3 Comment: Figure 1-2 shows the large disposal area as being larger than the TECHNOS report indicates.

Response: Magnetometry performed by E & E after the surface drums were removed indicates the area of buried metal as shown in Figure 1-2. Ref: Remedial Action Site Investigation, A. L. Taylor Site. Draft Report Ecology & Environment, Inc., April 1982 (performed under TDD F4-8109-05).

Page 1-3 Comment: Revise treatment plant process description to reflect current operational practice.

Response: The description reflects the treatment system as installed. Modification to the system resulting from operational practices will be covered on page 1-8.

Page 1-7 First paragraph: Insert Celanese Corporation to the list of companies which removed drums from the site. The number of drums removed by all six generators was actually 4,011 drums.

"and drums partially filled with solids" was taken from the official on-scene coordinator's site log.

Page 1-8 Comment: Include the history of startup and operational difficulties of the runoff treatment plant.

Response: The reconstructed runoff treatment plant was completed in December 1982 and startup operation undertaken. An evaluation of the difficulties associated with startup and operation of the wastewater treatment plant are beyond the scope of this report.

Page 1-9 Line 21 Correct 500 square feet to read 5000 square feet.

Page 1-9 Line 18 Comment: How was 31,000 yd^3 calculated?

Response: 31,000 cubic yards was calculated using 66,000 square feet of waste, 20 feet deep and assuming reasonable side slopes to the burial trenches.

Page 1-12 Line 1 Comment: This is ridiculous. There has been sufficient time to get the results.

Response: Analytical services are provided by EPA Contract Lab over which Ecology and Environment has no control. Geophysical data and chemical analysis of soil samples are published in the Remedial Action Site Investigation, A. L. Taylor Site, Draft Report. Ecology & Environment, Inc., April 1982.

Line 5 & Line 27 Comment: What is the source of these chemicals?

Response: Chemicals listed in first sentence of second paragraph are from Reference (EPA, 1982). Reference (EPA, 1979a) should be (EPA, 1980b).

Line 23 Comment: Should we address this as either being okay now or requiring Remedial Action and what are the references for this paragraph.

Response: In regard to comments about the third paragraph beginning "Surface water pollution", facts in this paragraph are supported by various reports and file entrees. Most of the data is historical that is prior to the 1980 emergency action. Water quality investigation of Wilson Creek was deleted from the Remedial Action Site Investigation as a cost control measure by EPA, Region IV. Given the lack of current data it is improper to speculate on the current condition of Wilson Creek.

Page 1-12 Comment: What is a relic farm pond?

Response: The valley which forms the headwaters for Wilson Creek has been dammed in the past. This area was filled in with vegetation and silt. The dam has been breached and the pond now slowly drains acting like a spring. Other E & E investigators believe this now constitutes a spring or is the location of a natural spring ponded by man.

Page 1-13 Comment: Table 1-2 does not include groundwater analyses.

Response: Some of the samples taken by EPA in 1979 were from holes dug in the site. This list of chemicals was developed as representative of the shallow ground water.

Page 1-14 Comment: The first paragraph is more conjecture. What does the geologic studies show?

Response: This paragraph is intended to enable the reader to understand the concerns at the site and not necessary to state facts which are presented in Chapter 4.

Page 1-14 Comment: Concerning the summary paragraph, the focus should be on the Concentrated Areas of contamination which we know about because of TECHNUS data and visual observation. These areas are:

1. Burial Trenches
2. Dump Pit
3. Leachate Plume Moving East From Dump Pit

Response: Concur

Page 2-1 Line 7 Comment: What is this about?

Response: The second paragraph discloses that the study purpose, objectives, and criteria were revised as the study proceeded to suit at available data.

Page 2-2 Insert the following sentence at the beginning of Section 2.2 Remedial Action Objectives. "To achieve the purpose of the remedial action, site specific objectives must be set to mitigate the site hazards."

Page 2-3 Line 2 Insert "and leachate" at the end of the first bulletin.

Line 3 Comment: What does this mean?

Response: The National Contingency Plan requires that natural resources damaged or potentially damaged by a site must be worth more than the cost of remedial action at that site to justify cleanup.

Page 2-4 Comment: Why is a qualitative assessment instead of a quantitative assessment used in the third paragraph?

Response: No air quality data exists. Current ground water data was not available until after the feasibility study was completed. Furthermore the toxilogical effects of various compounds singlely or in combinations on humans and anumals is not available in the literature. Finally the detailed

information needed on chemical concentrations and their spatial distribution is not available to make estimates of these compounds dispersion characteristics.

Page 3-4
Line 7

Comment: Where did this come from?

Response: The information below was developed by Ecology and Environment as a result of the Remedial Action Site Investigation.

The first paragraph of Section 3.4.1 Aquifer description is modified to read as follows: "Ground water at the site occurs in two different systems: a shallow unconfined residual soil moisture system and a deeper confined consolidated rock aquifer. The shallow system varies in thickness from approximately 3 to 25 feet with the depth of soil. Water levels from hand-augered wells in this shallow system range from 2.4 to 6.4 feet below land surface. Based on topography, shallow bedrock, and water levels in wells, the direction of ground water flow in the shallow system is from the hills southeasterly toward the valley of Wilson Creek. The rate of ground water movement is slow, 0.01 to 0.1 feet per year". Where appropriate, substitute shallow groundwater system for shallow aquifer in the remainder of Section 3.4.

Page 3-6

Comment: What happened to samples taken by Ecology & Environment in January 1982?

Response: The analytical results for these samples were not available until after this report was completed.

Page 3-18

Comment: Do we need air quality data and why was monitoring not performed?

Response: See the Response to Bowman Crums comment on the same matter. Monitoring was not performed because it was deleted from the Remedial Action Site Investigation by the Region IV Site Screening and Engineering Section.

Page 4-1

The following general comments were made about Section 4. Each comment is followed by an appropriate response.

Comment: There is also a layer of cinders at various points around the site, especially in the arena area, at a depth of 1.5 to 2.5 feet. This layer contains water and serves as a sort of conduit for groundwater migration.

Response: Well logs from borings completed by Ecology and Environment, Inc., in December 1981 and January 1982 did not identify any cinders. The cinder deposits are believed to be discontinuous and confined to the arena area. The arena area is generally upgradient from the major magnetic anomalies and the known areas of concentrated wastes. Therefore, the cinder layer is not of concern as a pollution conduit. Furthermore, this cinder layer is not known to outcrop any place on the site and thus contribute to surface water pollution. The proposed clay cap would cover most of the area of concern preventing migration to or from the cinder layer.

Comment: No mention is made of the leachate outbreaks visible around the site.

Response: The leachate outbreaks are the result of rainfall onto the site and are not caused by an organized groundwater flow or direct discharge of liquid wastes. Leachate flowing from the toe of dike around the remaining open pit on the north side of site is generated by storm water collecting in that pit and seeping through the dike. Other outbreaks are associated with the release of soil moisture in sloped terrain after periods of rainfall. These streams are not believed to be the result of an organized groundwater system such as a water table aquifer. Where this soil moisture has come in contact with contaminated soil and concentrated buried waste, it may act as a migration pathway. Waste burial trenches may have become saturated with moisture and contribute to these seeps.

Such seeps are currently intercepted by the runoff collection and treatment system. Treatment currently mitigates their impact on the surface waters. In the future, when a proposed landfill cap has been constructed, rainfall percolation and infiltration into the contaminated zones will be prevented, thereby eliminating the seeps. The direct contact hazard will also be eliminated by the placement of the clay cap.

Page 4-1 Delete the last sentence of paragraph 4. The E & E study in draft form became available in April of 1980.

Page 4-13 Limited chemical data on ground and surface water quality is presented in the draft report Remedial Action Site Investigation, A. L. Taylor Site. Ecology & Environment, Inc., April 1982.

Page 6-2 Comment: Concerning native soils used for cover material. Barry Burrus believes that the site soils used to cover and final grade the site were contaminated. Telephone conversation with Jim Aton 19 August 1982.

Response: No comment

Page 6-5 Comment: The treatment plant is not acceptable since the present system is not functioning.

Response: Ecology and Environment, Inc. believes that the treatment plant can be made to function with proper modification and a period of operational shakedown performed by personnel experienced in wastewater treatment plant operations.

Comment concerning paying for replacement treatment plant facilities.

Response: The costs presented assume the plant will not be replaced.

Page 6-21 Comment: The review disagrees with the statement "No additional socioeconomic impact will result from leaving the hazardous waste at the site."

Response: Kentucky personnel believe that the people will perceive an adverse impact if the minimum action alternative is implement because they have been told that the site will be cleaned up by the news media. The author recognizes this is a legitimate opinion but believes the cost of land, future land use and community infastructures need will not be significantly different from the base line situation. The minimum action alternative is essentially a continuation of the status quo.

Page 6-22 Comment: The same comment is made about the second paragraph, beginning "In summary, . . .", as above.

Response: See response to page 6-21.

Page 6-23 Line 17 & 18: 15-foot-deep small-diameter well should be 20-foot-deep.

Page 6-27 Comment: Was excavating the open pit and the surface dumping area included in this alternative?

Response: Provisions for excavating the Open Pit and the Surface Dumping Area shown in Figure 1-2 and relocating this waste under the proposed clay cap was unintentionally deleted from this alternative description. Cost of relocating this waste was included in the cost estimate.

Page 6-26 Line 22 Comment: Was the sand filter included in the salvage value?

Response: The value of the sand filter was not included in salvage value of the wastewater treatment plant because this filter belongs to O. H. Materials.

Page 6-30 Line 1 Comment: What is the permeability coefficient of the weathered shale?

Response: The permeability of the weathered shale has not been determined.

Page 6-34 Line 17 Comment: How was leachate volume calculated?

Response: Leachate volume is based on an engineering estimate of the permeability of the clay slurry wall at 10^{-8} cm per second and a conservative level of groundwater standing outside the slurry wall.

Page 6-44 and Page 6-53 Comment: What is the source of backfill clay?

Response: The brick company clay mine near the site was picked for cost estimating purposes. Other likely sources within a 2 mile radius of the site exist, such as Kentucky Soilite. The exact location of the borrow pit will be determined during the Remedial Design Task.

Page 6-55 Comment: Bottom of the page. Concern has been expressed that pit excavation may result in a large shock load to the treatment plant and result in pollution bypasses.

Response: It is reasonable to expect that cleanup contractors will use best management practices. As discussed on page 6-50, third paragraph, concentrated liquid wastes from the pits will be drummed and only diluted wastes will

be pumped to the treatment plant. Furthermore, the operation of the treatment plant during excavation will be under the supervision of the chief field chemist and frequently monitored for performance using the onsite chemistry laboratory.

Page 6-57
Line 1

Comment: Is this sentence correct?

Response: Revise the first sentence to read: "Ground Water beyond the boundries of the site will not be adversely affected by the excavation activities."

Page 6-60
Line 10

Comment: Is this sentence correct?

Response: First sentence to Surface Water should be modified to read as follows: Surface water and treatment plant effluent will discharge to Wilson Creek. During the excavation phase, the catchment lagoon and treatment plant will capture and treat all runoff.

Page 6-65

Comment: What was used?

Response: Trucking costs are based on calls to local contractor registered in the State of Kentucky.

APPENDIX A

PURPOSE, OBJECTIVES AND CRITERIA

The original draft of Section 2 as submitted to EPA for review earlier is provided here for reference.

CHAPTER 2 - PURPOSE, OBJECTIVES AND CRITERIA

The A. L. Taylor site presents the engineer with a broad problem involving a variety of contaminants and a number of pathways for the contaminants to affect the public health and welfare and the environment. The development of statement of purpose, site specific remedial response objectives and alternative evaluation criteria are an important step in the problem solving process.

2.1 STATEMENT OF PURPOSE

The purpose of the remedial response is the protection of the public health and welfare, and the environment from release of contaminants located within the A. L. Taylor site. The protection provided by the remedial action is to be the most cost effective means based on EPA's Best Scientific Judgement considering extent of the hazard, existing Federal and Kentucky environmental quality standards and criteria, and available technologies. This purpose is consistent with Section 104 of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or "Superfund Act") and the proposed National Contingency Plan. The following is a quote from Section 104 which defines appropriate remedial actions:

> The President shall select appropriate remedial actions determined to be necessary to carry out this section which are to the extent practicable in accordance with the national contingency plan and which provide for that cost-effective response which provides a balance between the need for protection of public health and welfare and the environment at the facility under consideration, and the availability of amounts from the Fund established under title II of this Act to respond to other sites which present or may present a threat to public health or welfare or the environment, taking into consideration the need for immediate action.

2.2 REMEDIAL ACTION OBJECTIVES

To achieve the purpose of the remedial action, site specific objectives must be set to control the problem. A brief statement of the problem as discussed in Chapter One is the environmental release of over 114 chemicals identified in environmental samples associated with the site, by way of the air, the surface water, the ground water and the soil. The remedial action must therefore attenuate the environmental release of these contaminants by the application of appropriate technologies. Furthermore, the technology selected must be the most cost-effective.

The objectives must be broad in nature because of the complexity of the problem. The degree of hazard associated with each hazardous chemical release varies with the chemical type, the medium of release, and the sensitivity of the human or environmental receptors. Receptor sensitivity is ideally the factor defining the appropriate level of clean-up. Only a limited body of knowledge is available on the sensitivity of these receptors to the chemicals of concern. Therefore, established Federal and Kentucky standards will be used as guideline for defining the acceptable level of clean-up. Where such standards have not been developed best scientific judgement will be used.

Considering the above, the following are the remedial action objectives for cleaning up the A. L. Taylor site:

- The air quality will be protected by the control of emissions of particulate matter, volatile organic compounds, and toxic gases.
- The surface water of Wilson Creek will be protected from leachate and runoff.
- Ground water which is used for domestic, agriculture or industrial water supply or contributes to the surface water will be protected from contamination.
- The casual site visitor will be protected from direct contact with contaminated soils.
- The commitment of natural resources at the A. L. Taylor site will be the most cost-effective commitment of those resources.

2.3 EVALUATION CRITERIA

The criteria developed to meet the above objectives must provide: (1) protection of the environment and the public health and welfare, and (2) qualitative and quantitative comparison between alternatives. Environmental standards have not been developed for all the chemicals and release pathways occuring at the A. L. Taylor site. Because engineering solutions for abatement of hazardous contaminant releases are still undergoing development, abatement efficiencies for various techniques are difficult to predict. Furthermore, only limited site characterization information is available which limits the confidence level in comparing cost-effectiveness of alternatives.

Recognizing these shortcomings, the following criteria will be applied appropriately. Existing EPA and Kentucky environmental standards and criteria will be used as guidelines to establish acceptable ambient contamination levels for those contaminants with standards. Contaminants without standards will be assumed to be adequately controlled when those contaminants with standards are controlled. Alternative design solutions will be compared with the engineering design criteria developed under RCRA for permitting new hazardous waste landfills. When quantitative comparisons cannot be made because of insufficient environmental data or lack of established criteria, the alternatives will be ranked in their relative acceptability using best scientific judgement.

2.3.1 Environmental Criteria

The Environmental criteria must consider the four pathways that might transport contaminants to the off-site environment; air, surface water, ground water, and soils. Certain elements of the site environment presently may not attain established standards. In those cases best scientific judgement will be used to determine the risk of additional contaminant release. The following environmental criteria will be used as guidelines in evaluating the level of performance of the remedial action alternatives;

- Ambient air quality - - Federal and Kentucky ambient air quality standards given in Table 2-1.

- o Surface water quality - - Kentucky and Federal stream standards given in Table 2-2 or applicable water quality standards (human health standard) for priority pollutants given in Table 2-3.

- o Ground water quality - - surface water standards given above or drinking water standards given in Table 2-4.

- o Soils - - no contact with the casual site visitor.

- o Natural Resource commitment - - the perpetual commitment of a natural resource to contamination will be more cost-effective than cleaning up that resource.

2.3.2 Comparative Criteria

Comparative criteria can be divided into two categories, (1) qualitative or (2) quantitative. Reliability, implementability, engineering design, environmental concerns and safety requirements will be compared on a qualitative basis. Operation and maintenance effort and costs will be compared on a quantitative basis.

Reliability is the extent to which a system, device, or technology will perform a desired function correctly for a number of repeated trials or for an extended period of time. Without test data measuring performance against an established standard, reliability of each alternative is a scientific judgement. The alternatives will be ranked as to their relative reliability without attempting to establish the quantitative reliability of each alternative.

Implementability is the physical, mental, financial and legal power to carry out the alternative. Because of the varied nature of the possible remedial alternatives, the alternatives will be ranked based on their ease of implementation. Consideration will be given to public opinion, regulatory procedures, duration, scheduling natural constraints (such as weather), and technical feasibility. The most easily implemented alternative will be preferred.

Engineering design is the criterion where each alternative design will be compared to new landfill design permitted under RCRA. The alternative which has environmental protection performance similar or superior to a RCRA permitted landfill will be given preference.

Environmental concerns will be identified for each alternative in the environmental assessment process. Concerns generated for each alternative will be ranked as to relative importance. The alternative with the least adverse environmental impact will receive preference.

Safety requirements of each alternative will be developed to mitigate corresponding risks. The level of on-site and off-site operations, and the degree of hazard presented by the material being handled will determine the safety requirements. Where necessary, risk assessments will be made on each operation. The safety requirements and relative risk of each alternative will be compared and the alternatives ranked. Preference will be given to the alternative having the lowest relative risk and safety requirements.

Operation and maintenance efforts for both the long-term and short-term will be developed for each alternative. Manpower and equipment requirements will be identified for the 30-year project period. Maintenance effort will be based on parts replacement, corrosion control and safety requirements. Operation personnel, utility costs, and major system replacement requirements for each alternative will be developed. When comparing alternatives, those with the least long term commitment of capital, manpower and equipment will be preferred.

Life cycle cost will be developed for each alternative. The life cycle of the facility will be 30 years as required by the Solid Waste Act closure policy. Twelve percent annual interest will be assumed to estimate the cost of financing each alternative. Labor, material, and utility costs will be assumed to escalate ten percent per year. The cost of all alternatives will be compared and the alternatives will be ranked, with preference given to the least expensive remedial response alternative.

TABLE 2-1
NATIONAL PRIMARY AND SECONDARY AMBIENT AIR QUALITY STANDARDS

Pollutant	Type of standard	Averaging time	Frequency parameter	Concentration ug/m³	Concentration ppm
Carbon monoxide	Primary and secondary	1 hr	Annual maximum[a]	40,000	35
		8 hr	Annual maximum	10,000	9
Hydrocarbons (nonmethane)	Primary and secondary	3 hr (6 to 9 a.m.)	Annual maximum	160[b]	0.24[b]
Nitrogen dioxide	Primary and secondary	1 yr	Arithmetic mean	100	0.05
Photochemical oxidants[c]	Primary and secondary	1 hr	Annual maximum	160	0.08
Particulate matter	Primary	24 hr	Annual maximum	260	-
		24 hr	Annual geometric mean	75	-
	Secondary	24 hr	Annual maximum	150	-
		24 hr	Annual geometric mean	60[d]	-
	PSD[e] increment	24 hr	Annual overage	19	-
		24 hr	Daily maximum	37	-
Sulfur dioxide	Primary	24 hr	Annual maximum	365	0.14
		1 yr	Arithmetic mean	80	0.03
	Secondary	3 hr	Annual maximum	1,300	0.5
Lead	Primary	90 day		1.5	
Ozone	Primary and Secondary	1 hr		235	0.12

[a] Not to be exceeded more than once per year
[b] As a guide in devising implementation plans for achieving oxidant standards
[c] Expressed as ozone by the Federal Reference Method
[d] As a guide to be used in assessing implementation plans for achieving the annual maximum 24-hour standard.
[e] Prevention of significant deterioration permitted increments

TABLE 2-2
APPLICABLE KENTUCKY STREAM WATER QUALITY STANDARDS
FOR WARM WATER AQUATIC HABITAT

Water Quality Characteristic or Pollutant	Criteria
Aesthetic Qualities	Surface waters shall not be aesthetically or otherwise degraded by substances that: (1) Settle to form objectionable deposits; (2) Float as debris, scum, oil, or other matter to form a nuisance; (3) Produce objectionable color, odor, taste or turbidity; (4) Injure, be toxic to or produce adverse physiological or behavioral responses in humans, fish, shellfish, and aquatic life; (5) Produce undesirable aquatic life or result in the dominance of nuisance species;
Alkalinity	20 mg/l or more as $CaCO_3$ natural alkalinity as $CaCO_3$ shall not be reduced by more than twenty-five (25) percent. Where natural alkalinity is below twenty (20) mg/l $CaCO_3$ no reduction below the natural level is allowed. Alkalinity shall not be reduced to a degree which may adversely affect the aquatic community.
pH	Between 6 and 9 and no fluctuations of more than 1 unit within any 24 hour period.
Flow	Flow shall not be altered to a degree which will adversely affect the aquatic community.
Temperature	Not applicable
Dissolved Oxygen	5 mg/l daily average but not less than 4 mg/l instantaneously.
Total dissolved solids	Total dissolved solids shall not be changed to the extent that the indigenous aquatic community is adversely affected.

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TABLE 2-2
APPLICABLE KENTUCKY STREAM WATER QUALITY STANDARDS
FOR WARM WATER AQUATIC HABITAT

Water Quality Characteristic or Pollutant	Criteria
Total suspended solids	Total suspended solids shall not be changed to the extent that the indigenous aquatic community is adversely affected. The addition of settleable solids that may adversely alter the stream bottom is prohibited.
Ammonia	0.05 mg/l or less after instream mixing.
Toxics	(1) The allowable instream concentrations of toxic materials which are noncumulative and nonpersistent shall not exceed 0.1 of the ninety-six (96) hour median lethal concentration (LC_{50}) of a representative indigenous aquatic organism.
	(2) The allowable instream concentration of toxic substances, including pesticides, shall not exceed 0.01 of the ninety-six (96) hour median lethal concentration (LC_{50}) of a representative indigenous aquatic organism.
Arsenic[1]	50 ug/l or less
Beryllium[1]	11 ug/l soft water[2] or less 1100 ug/l hard water[2] or less
Cadmium[1]	4.0 ug/l soft water[2] or less 12.0 ug/l hard water[2] or less
Chlorine, total, residual	10 ug/l or less
Chromium[1]	100 ug/l or less
Cyanide, Free	5 ug/l or less
Hydrogen Sulfide (undissociated)	2 ug/l or less
Iron[1]	1.0 mg/l[3] or less
Mercury[1]	0.05 ug/l or less
Phthalate Esters	3 ug/l or less
Phenol	5 ug/l or less

[1] Metal criteria, for purposes of this regulation, are total metals to be measured in an unfiltered sample.

[2] Soft water has an equivalent concentration of calcium carbonate ($CaCO_3$) of 0 to 75 mg/l, and hard water has an equivalent concentration of calcium carbonate ($CaCO_3$) of over 75 mg/l.

[3] For low flow streams, the daily average total iron concentration is limited to 3.5 mg/l when it is established that there will be no damage to aquatic life.

TABLE 2-3
HUMAN HEALTH STANDARDS FOR INJESTION OF WATER
AND AOUATIC ORGANISMS CONTAMINATED WITH SELECTED
PRIORITY POLLUTANTS[a]

SUBSTANCE	HUMAN HEALTH STANDARD
Antimony	146 ug/L
Beryllium	0
Cadmium	10 ug/L
Chromium	170 mg/L
Copper	Not Available
Lead	50 ug/L
Nickel	13.4 ug/L
Silver	50 ug/L
Thallium	13 ug/L
Zinc	Not Available
PCB-1242	0
PCB-1248	0
PCB-1254	0
PCB-1260	0
1,2-Benzanthracene	0
Fluoranthene	42 ug/L
Pyrene	0
Naphthalene	0
Fluorene	0
Anthracene	0
Acenaphthene	0
Bis (2-Ethylhexyl) Phthalate	15 mg/L
Butyl Benzyl Phthalate	Not Available
Di-N-Octyl Phthalate	Not Available
Di-N-Butyl Phthalate	Not Available
Dimethyl Phthalate	313 mg/L
Diethyl Phthalate	350 mg/L
Pentachlorophenol	1.01 mg/L
Phenol	3.5 mg/L
3,3'-Dichlorobenzidine	0
Hexachlorobenzene	0
1,2,4-Trichlorobenzene	Not Available
Benzene	0
Ethyl Benzene	0
Isophorone	5.2 mg/L
Toluene	14.3 mg/L
Vinyl Chloride	0
Methylene Chloride	0
Trans-1,2-Dichloroethylene	Not Available
Trichloroethylene	0
Tetrachloroethylene	0
1,1,1-Trichloroethane	18.4 mg/L

[a] Only priority pollutants detected at quantifiable limits in the environmental samples taken at the A. L. Taylor site are listed.

TABLE 2-4
NATIONAL SAFE DRINKING WATER STANDARDS

CONTAMINANT	MAXIMUM LEVEL (mg/l)
Primary Standards	
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Fluoride	1.4-2.4
Lead	0.05
Mercury	0.002
Nitrate (as N)	10
Selenium	0.01
Silver	0.05
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5-TP Silver	0.01
Radium	5 pCi/l
Gross Alpha	15 pCi/l
Gross Beta	4 millirem/yr
Turbidity	1/TU
Coliform Bacteria	1/100 ml
Secondary Standards	
Chloride	250 mg/l
Color	15 color units
Copper	1 mg/l
Corrosivity	Noncorrosive
Foaming agents	0.5 mg/l
Hydrogen sulfide	0.05 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Odor	3 Threshold Odor Numbe
pH	6.5 - 8.5
Sulfate	250 mg/l
Total Disolved Solids	500 mg/l
Zinc	5 mg/l

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APPENDIX E

SPECIES LISTS

Appendix

Species Lists

TABLE B-1

MAMMALS WHICH OCCUR IN THE NORTHCENTRAL KENTUCKY REGION ACCORDING TO BURT AND GROSSENHEIDER (1976)

SCIENTIFIC NAME	COMMON NAME
Didelphis marsupialis	Opossum
Sorex fumeus	Smokey shrew
S. longirostris	Southeastern shrew
Cryptotis parva	Least shrew
Blarina brevicaudo	Shorttail shrew
Scalopus aquaticus	Eastern mole
Myotis keeni	Keen's myotis
M. lucifugus	Little brown myotis
M. sodalis	Indiana myotis
M. subulatus	Small-footed myotis
Lasionycteris noctivagans	Silver-haired bat
Pipistrellus subflavus	Eastern pipestrel
Lasiurus borealis	Red bat
Eptesicus fuscus	Big brown bat
Lasiurus cinereus	Hoary bat
Nycticeius humeralis	Evening bat
Plecotus townsendi	Western big-eared bat
P. rafinesquei	Eastern big-eared bat
Procyon lotor	Racoon
Mustela frenata	Longtail weasal
M. vison	Mink
Lutra canadensis	River otter
Sylvilagus floridanus	Eastern cottontail
Spilogale putorius	Spotted skunk
Mephitis mephitis	Striped skunk
Canis latrans	Coyote
Vulpes fulva	Red fox
Urocyon cinereoargenteus	Gray fox
Marmota monax	Woodchuck
Tiamias striatus	Eastern chipmunk
Sciurus carolinensis	Eastern gray squirrel
S. niger	Eastern fox squirrel
Glaucomys volans	Southern flying squirrel
Castor canadensis	Beaver
Reithrodontomys humilis	Eastern harvest mouse
Peromyscus levopus	White-footed mouse
P. maniculatus	Deer mouse
P. gossypinus	Cotton mouse
P. nuttali	Golden mouse
Neotoma floridana	Eastern woodrat
Oryzomys palustris	Rice rat
Synaptomys cooperi	Southern bog lemming
Microtus pennsylvanicus	Meadow vole
M. ochrogaster	Prairie vole

TABLE B-1 (continued)

MAMMALS WHICH OCCUR IN THE NORTHCENTRAL KENTUCKY REGION ACCORDING TO BURT AND GROSSENHEIDER (1976)

SCIENTIFIC NAME	COMMON NAME
Pitymys pinetorum	Pine vole
Ondatra zibethica	Muskrat
Zapus hudsonius	Meadow jumping mouse
Rattus norvegicus	Norway rat
Mus musculus	House mouse
Odocoileus virginianus	White-tail deer

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TABLE B-2

REPTILES AND AMPHIBIANS OCCURRING IN THE NORTHCENTRAL KENTUCKY REGION ACCORDING TO THE AUDUBON SOCIETY (1979)

SCIENTIFIC NAME	COMMON NAME
Chelydra serpentina	Snapping turtle
Sternotherus odoratus	Stinkpot
Chrysemys picta	Painted turtle
C. scripta	Pond slider
Graptemys geographica	Map turtle
Terrapene carolina	Box turtle
Trionyx muticus	Smooth softshell
T. spiniferus	Spiny softshell
Sceloporus undulatus	Fence lizard
cnemidophorus sexlineatus	Racerunner
Eumeces fasciatus	Five-lined skink
E. laticeps	Broad-headed skink
Scincella lateralis	Ground skink
Carphophis amoenus	Worm snake
Cemophora coccineo	Scarlet snake
Clonophis kirtlandi	Kirtland's snake
Coluber constrictor	Racer
Diadophis punctatus	Ringneck snake
Elaphe quttata	Corn snake
E. obsoleta	Rat snake
Heterodon platychinus	Hognose snake
Lampropeltis calligaster	Prairie kingsnake
L. getulus	King snake
L. triangulum	Milk snake
Nerodia erythrogaster	Plain-bellied water snake
Natrix sipedon	Northern water snake
Upheodrys aestivus	Rough green snake
O. vernalis	Smooth green snake
Pipuophis melanoleucus	Pine gopher snake
Regina septumvittata	Queen snake
Storeria dekayi	Brown snake
S. occipitomaculata	Red-bellied snake
Tantilla cprpmata	Crowned snake
Thamnophis sauritus	Eastern ribbon snake
T. sirtalis	Garter snake
Virginia valeiae	Smooth earth snake
Agkistrodon contortrix	Copperhead
Crotalus horridus	Timber rattlesnake
Sistrurus catenatus	Massasauga
Cryptobranchus alleganiensis	Hellbender
Notophthalmas viridens	Eastern newt
Necturus maculosus	Mudpuppy
Ambystoma jeffersonianum	Jefferson salamander
A. maculatum	Spotted salamander

TABLE B-2 (continued)

REPTILES AND AMPHIBIANS OCCURRING IN THE NORTHCENTRAL KENTUCKY REGION ACCORDING TO THE AUDUBON SOCIETY (1979)

SCIENTIFIC NAME	COMMON NAME
A. opacum	Marbled salamander
A. texanum	Small-mouthed salamander
A. tigrinum	Tiger salamander
Desmognathus fuscus	Dusky salamander
Eurycea bislineata	Two-lined salamander
E. longicauda	Long-tailed salamander
E. lucifuga	Cave salamander
Hemidactylium scutatum	Four-toed salamander
Plethodon dorsalis	Zig-zag salamander
P. glutinosus	Slimy salamander
P. richmondi	Ravine salamander
Pseudotriton montanus	Mud salamander
P. ruber	Red salamander
Scaphiopus holbrooki	Eastern spadefoot frog
Rana blairi	Plains leopard frog
R. catesbeiana	Bullfrog
R. clamitans	Green frog
R. palustris	Pickeral frog
R. pipiens	Northern leopard frog
R. sphenocephala	Southern leopard frog
R. sylvatica	Wood frog
Bufo americanus	American toad
B. Woodhousei	Woodhouse's toad
Acris crepitans	Northern cricket frog
Hyla chrysoscelis	Cope's Gray Treefrog
H. versicolor	Common Gray Treefrog
H. crucifer	Spring peeper
Pseudacris branchyphona	Mountain chorus frog
P. triseriata	Chorus frog

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TABLE B-3

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Gavia immer	Common loon	common only in fall	transient & winter visitant
G. stellata	Red-throated loon	uncommon	spring visitant
Podiceps grisegena	Red-necked grebe	very rare	fall, winter & winter visitant
P. auritus	Horned grebe	common during migration (not winter)	transient and winter visitant
P. nigricollis	Eared grebe	rare	winter and spring visitant
Aechmophorus occidentalis	Western grebe	very rare	winter visitant
Podilymbus podiceps	Pied-billed grebe	common in migration (not summer & winter)	resident
Ardea herodias	Great blue heron	common in migration (rare winter & summer)	transient & visitant
Butorides virescens	Green heron	common summer accidental winter	summer resident winter visitant
Florida caerulea	Little blue heron	uncommon/rare	visitant
Bubulcus ibis	Cattle egret	very rare	spring visitant

TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Casmerodius albus	Great egret	uncommon	visitant
Egretta thula	Snowy egret	rare	spring and fall visitant
Nycticorax nycticorax	Black-crowned night heron	uncommon	summer resident
N. *violocea*	Yellow-crowned night heron	uncommon	summer resident
Ixobrychus exilis	Least bittern	uncommon/rare	transient
Botanurus lentiginosus	American bittern	uncommon/rare	transient
C. *columbianus*	Whistling swan	rare	transient and winter visitant
Phalacrocorax auritus	Double creasted cormorant	rare to casual	visitant
Branta canadensis	Canada goose	common	resident
Anser albifrons	White-fronted goose	very rare	spring and fall visitant
Chen caerulescens	Snow goose	rare	transient and visitant
Anas platyrhynchos	Mallard	common	resident
A. *rubripes*	Black duck	common winter rare summer	winter resident summer visitant

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
A. strepera	Gadwall	common spring rare otherwise	winter resident spring transient
A. acuta	Pintail	uncommon/rare	transient and visitant
A. crecca	Green-winged teal	uncommon/rare	transient and winter visitant
A. discors	Blue-winged teal	common in migration	transient and summer resident
A. penelope	European wigeon	uncommon	spring visitant
A. americana	American wigeon	common spring rare otherwise	transient and winter resident
A. clypeata	Northern shoveler	common spring rare otherwise	transient and winter visitant
Anix sponsa	Wood duck	common except in winter	resident
Aythya americana	Redhead	uncommon	winter resident
A. collaris	Ring-necked duck	common	transient and winter resident
A. valisineria	Canvasback	fairly common	winter resident
A. marila	Greater scaup	uncommon/rare	winter resident

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
A. affinis	Lesser scaup	common in winter	winter resident summer visitant
Bucephala clangula	Common goldeneye	uncommon	winter resident
B. albeola	Bufflehead	uncommon	winter resident
Clangula hyemalis	Oldsquaw	rare	winter visitant
Melanitta deglandi	White-winged scoter	rare	winter visitant
M. nigra	Black scoter	rare	winter visitant
Oxyura jamaicensis	Ruddy duck	uncommon/rare	transient and visitant
Lophodytes cucullatus	Hooded merganser	common spring rare otherwise	resident
Mergus merganser	Common nerganser	uncommon/rare	winter resident
M. serrator	Red-breasted merganser	common in migration	transient & rare winter resident
Cathartes aura	Turkey vulture	common in migration and summer	resident
Coragyps atratus	Black vulture	uncommon/rare	resident
Ictinia misisippiensis	Mississippi kite	very rare	spring and summer visitant

TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Accipiter gentilis	Goshawk	rare	winter visitant
A. *striatus*	Sharp-shinned hawk	uncommon/rare	visitant
A. *cooperii*	Cooper's hawk	uncommon/rare	resident
Buteo jamaicensis	Red-tailed hawk	common winter uncommon summer	resident
B. *lineatus*	Red-shouldered hawk	uncommon/rare	resident
B. *platypterus*	Broad-winged hawk	common in migration uncommon summer	transient and summer resident
B. *lagopus*	Rough-legged hawk	uncommon/rare	winter visitant
Aquila chrysaetos	Golden eagle	uncommon	winter visitant
Haliaeetus leucocephalus	Bald eagle	rare	transient and winter visitant
Circus cyanus	Marsh hawk	uncommon/rare	transient and visitant
Pandion haliaetus	Osprey	uncommon	transient and winter visitant
Falco peregrinus	Peregrine falcon	very rare	visitant

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
F. columbarius	Merlin	rare	transient and winter visitant
F. sparverius	American kestrel	common	resident
Banasa umbellus	Ruffed grouse	rare	resident
Colinus virginionus	Bobwhite quail	common	resident
Alectoris chukar	Chukar	very rare	resident
Meleagris gallopavo	Turkey	rare	resident
G. canadensis	Sandhill crane	rare	transient and winter visitant
Rallus elegans	King rail	very rare	transient and summer resident
R. limicola	Virginia rail	rare/casual	transient and winter visitant
Porzana carolina	Sora	uncommon/casual	transient and summer visitant
Gallinula chloropus	Common gallinule	rare	transient
Fulica americana	American coot	common in migration rare otherwise	transient and visitant

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Charadrius semipalmatus	Semipalmated plover	common in fall	transient and summer visitant
C. melodus	Piping plover	rare	fall transient
C. vociferus	Killdeer	common summer uncommon otherwise	resident
Pluvialis dominica	American golden plover	uncommon/rare	transient
P. squatarola	Black-bellied plover	uncommon/rare	transient
Arenaria interpres	Ruddy turnstone	uncommon/rare	transient
Philohela minor	American woodcock	uncommon/rare	resident
Gallinago gallinago	Common snipe	common in migration, rare otherwise	transient and winter resident
Bartramia longicauda	Upland sandpiper	uncommon/rare	transient and summer visitant
Actitis macularia	Spotted sandpiper	common in migration rare otherwise	transient and summer resident
Tringa solitaria	Solitary sandpiper	common	transient
T. melanoleuca	Greater yellowlegs	uncommon to fairly common	transient
T. flavipes	Lesser yellowlegs	common	transient

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Catoptrophorus semipalmatus	Willet	rare/casual	transient
Calidris canutus	Red knot	rare	fall transient
C. melanotos	Pectoral sandpiper	common in migration uncommon otherwise	transient and visitant
C. fuscicollis	White-rumped sandpiper	rare/casual	transient
C. bairdii	Baird's sandpiper	uncommon/rare	fall transient
C. minutilla	Least sandpiper	common in migration rare otherwise	transient and winter visitant
C. alpina	Dunlin	uncommon/rare/casual	transient and winter visitant
C. pusilla	Semipalmated sandpiper	common spring uncommon otherwise	transient
C. mauri	Western sandpiper	uncommon/common fall, casual summere	fall transient summer visitant
C. alba	Sanderling	uncommon/rare	fall transient
Linonodromus griseus	Short-billed dowitcher	uncommon/common fall, rare otherwise	transient
L. scolopaceus	Long-billed dowitcher	uncommon	fall transient

TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Micropalama himantopus	Stilt sandpiper	uncommon/rare	transient
Tryngites subruficollis	Buff-breasted sandpiper	uncommon/rare	fall transient
Recurvirostra americana	American avocet	rare	fall visitant
Phalacropus fulicarius	Red phalarope	very rare	fall transient winter visitant
Steganopus tricolor	Wilson's phalarope	rare	transient
Lobipes lobatus	Northern phalarope	rare	fall transient
Larus hyperboreus	Glaucous gull	rare	winter visitant
L. *argentatus*	Herring gull	common winter, casual summer	winter resident summer visitant
L. *delawarensis*	Ring-billed gull	common winter, rare otherwise	winter resident summer visitant
L. *atricilla*	Laughing gull	very rare	spring visitant
L. *pipixcan*	Franklin's gull	rare/casual	transient and winter visitant
L. *philadelphia*	Bonaparte's gull	casual/uncommon/rare	transient and winter visitant
Rissa tridactyla	Black-legged kittlwake	uncommon	casual winter visitant

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Sterna forsteri	Forster's tern	uncommon/rare	transient
S. *hirundo*	Common tern	uncommon/rare	transient and summer visitant
S. *albifrons*	Least tern	uncommon/rare/casual	fall transient summer resident
Hydroprogne caspia	Caspian tern	uncommon/rare/casual	transient and summer visitant
Chlidonias niger	Black tern	rare to common	transient
Columba livia	Rock dove	common	resident
Zenaida macroura	Mourning dove	common	resident
Coccyzus americanus	Yellow-billed cuckoo	common	summer resident
C. *erythropthalmus*	Black-billed cuckoo	uncommon	transient
Tyto alba	Barn owl	rare	resident
Otus asio	Screech owl	common to uncommon	resident
Bubo virginianus	Great horned owl	common to uncommon	resident
Nyctea scandiaca	Snowy owl	very rare	winter visitant
Strix varia	Barred owl	fairly common	resident

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
A. flammeus	Short-eared owl	uncommon	winter visitant
Caprimulgus vociferus	Whip-or-will	farily common	summer resident
Chordeiles minor	Common nighthawk	fairly common	summer resident
Chaetura pelagica	Chimney swift	common	summer resident
Archilochus colubris	Ruby-throated hummingbird	farily common	summer resident
Megaceryle alcyon	Belted kingfisher	uncommon to fairly common	resident
Colaptes auratus	Common flicker	common	resident
Dryocopus pileatus	Pileated woodpecker	ucommon to fairly common	resident
Centrus carolinus	Red-bellied woodpecker	common	resident
Melanerpes erythrocephalus	Red-headed woodpecker	rare winter, common to uncommon summer	resident
Sphyrapicus various	Yellow-bellied sapsucker	fairly common in migration, uncommon otherwise	transient and winter resident
Dendrocopus villosus	Hairy woodpecker	uncommon to fairly common	resident
D. pubescens	Downy woodpecker	common	resident
Tyrannus tyrannus	Eastern kingbird	common	summer resident
Myiarchus crinitus	Great crested flycatcher	common	summer resident

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Sayornis phoebe	Eastern phoebe	fairly common, summer, rare otherwise	resident
Empidomax flaviventris	Yellow-bellied flycatcher	uncommon/rare	transient
E. virescens	Acadian flycatcher	fairly common	summer resident
E. traillii	Willow flycatcher	uncommon	summer resident
E. minimus	Least flycatcher	common	transient
Contopus virens	Eastern wood pewee	common	summer resident
Nuttallornis borealis	Olive-sided flycatcher	rare	transient
Eremophila alpestris	Horned lark	fairly common	resident
Iridoprocne bicolor	Tree swallow	uncommon	transient and visitant
Riparia riparia	Bank swallow	common in migration, rare otherwise	transient and summer resident
Stelgidopteryx ruficollis	Rough-winged swallow	fairly common	summer resident
Hirundo rustica	Barn swallow	common	summer resident
Petrochelidon pyrrhonoto	Cliff swallow	rare	transient and summer visitant
Progne subris	Purple martin	common in summer only	summer resident

ALT 001 000558

TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Cyanocitta cristata	Bluejay	common	resident
Parus carolinensis	Tufted titmouse	common	resident
Sitta carolinensis	White-breasted nuthatch	fairly common	resident
S. canadensis	Red-breasted nuthatch	rare to fairly common	winter resident
Certhia familiaris	Brown creeper	fairly common	winter resident
Troglodytes aedon	House wren	common summer, casual winter	summer resident winter visitant
T. troglodytes	Winter wren	uncommon to farily common	winter resident
Thryothorus bewickii	Bewick's wren	uncommon/rare	resident
T. ludovicianus	Carolina wren	common	resident
Telmatodytes palustris	Long-billed marsh wren	rare to casual	transient and winter visitant
Cistothorus platensis	Short-billed marsh wren	uncommon/rare	resident
Mimus polyglottus	Mockingbird	common	resident
Dumetella carolinensis	Gray catbird	common summer rare winter	summer resident winter visitant
Toxostoma rufum	Brown thrasher	common summer, uncommon winter	resident

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Turdus migratorius	American robin	common	resident
Hylocichla mustelina	Wood thrush	common	summer resident
Catharus guttatus	Hermit thrush	fairly common in migration, rare otherwise	transient and winter visitant
C. ustulatus	Swainson's thrush	common	transient
C. minimus	Gray-cheeked thrush	fairly common	transient
C. fuscescens	Reery	uncommon to fairly common in spring	transient
Sialis sialis	Eastern bluebird	fairly common	resident
Polioptila caerulea	Blue-gray gnatcatcher	fairly common	summer resident
Regulus satrapa	Golden-crowned kinglet	common to uncommon	transient and winter resident
R. calendula	Ruby-crowned kinglet	common in migration, rare otherwise	transient and winter resident
Anthus spinoletta	Water pipit	rare	transient and winter resident
Bombycilla cedrorum	Cedar, waxwing	common in migration, uncommon otherwise	resident
Lanius ladovicianus	Loggerhead shrike	uncommon	resident

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Sturnus vulgaris	Starling	abundant	resident
Vereo griseus	White-eyed vereo	fairly common	summer resident
V. bellii	Bell's vireo	very rare	transient
V. flavifrons	Yellow-throated vireo	fairly common	summer resident
V. solitarius	Solitary vireo	uncommon to casual	transient and summer visitant
V. olivaceus	Red-eyed vireo	common	summer resident
V. philadelphicus	Philadelphia vireo	uncommon/rare	transient
V. gilves	Warbling vireo	uncommon to common	summer resident
Mniotilta varia	Black-and-White warbler	common in migration, uncommon otherwise	transient and summer resident
Protomotaria citrea	Swainson's warbler	uncommon	summer resident
Helmitheros vermivorus	Worm-eating warbler	uncommon/rare	transient and summer resident
Vermivora pinus	Blue-winged warbler	common springs, uncommon otherwise	transient and summer resident
V. chrysoptera	Golden-winged warbler	uncommon/rare	transient
V. peregrina	Tennessee warbler	common	transient

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
V. celata	Orange-crowned warbler	rare	transient
V. ruficapilla	Nashville warbler	common spring, uncommon otherwise	transient
Parula americana	Northern parula	uncommon to rare	transient and summer visitant
Dendroica petechia	Yellow warbler	common in migration, uncommon otherwise	transient and summer resident
D. magnolia	Magnolia warbler	common	transient
D. tigrina	Black-throated blue warbler	rare	transient
D. coronata	Yellow-rumped warbler	common in migration, uncommon otherewise	transient and winter resident
D. virens	Black-throated green warbler	common	transient
D. cerulea	Cerulean warbler	uncommon	summer resident
D. fusca	Blackburnian warbler	common to uncommon spring and fall	transient
D. dominica	Yellow-throated warbler	common to uncommon	summer resident
D. pensylvanica	Chestnut-sided warbler	fairly common	transient

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
D. castanea	Bay-breasted warbler	common in fall uncommon otherwise	transient
D. striata	Blackpole warbler	fairly common spring casual fall	transient
D. pinus	Pine warbler	fairly common	transient and summer resident
D. discolor	Prairie warbler	common to uncommon	summer resident
D. palmarum	Palm warbler	common in migration, rare otherwise	transient and winter visitant
Seiurus aurocapillus	Ovenbird	uncommon to common	summer resident winter visitant
S. noveboracensis	Northern waterthrush	fairly common spring, rare otherwise	transient
S. motacilla	Louisiana waterthrush	uncommon	summer resident
Oporornis formosus	Kentucky warbler	fairly common	summer resident
O. agilis	Connecticut warbler	rare	transient
O. philadelphia	Mourning warbler	uncommon/rare	transient
Geothlypis trichas	Common yellow throat	common summer casual winter	summer resident winter visitant

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Icteria virens	Yellow-breasted chat	uncommon to fairly common	summer resident
Wilsonia citrina	Hooded warbler	fairly common spring uncommon otherwise	transient and summer resident
W. pusilla	Wilson's warbler	uncommon/rare	transient and winter visitant
W. canadensis	Canada warbler	common fall, uncommon otherwise	transient
Setophaga ruticilla	American redstart	common in migration, rare otherwise	transient and summer visitant
Passer domesticus	House sparrow	abundant	resident
Dolichonyx oryzivorus	Boblink	fairly common spring, uncommon otherwise	transient and summer resident
Sturnella magna	Eastern meadowlark	common	resident
S. neglecta	Western meadowlark	very rare	spring and winter visitant
Xanthocephalus xanthocephalus	Yellow-headed blackbird	very rare	spring and fall visitant
Agelaius phoeniceus	Red-winged blackbird	common	resident
Icterus spurius	Orchard oriole	fairly common spring and summer	summer resident

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
I. galbula	Northern oriole	common in migration, casual/uncommon otherwise	summer resident winter visitant
Euphagus carolinus	Rusty blackbird	uncommon to common	transient and winter resident
E. cyanocephalus	Brewer's blackbird	rare to casual	transient and winter visitant
Quiscalus quiscalus	Common grackle	abundant	resident
Molothrus ater	Brown-headed cowbird	common	resident
Pirange olivacea	Scarlet tanager	uncommon to fairly common	transient and summer resident
P. ludoviciana	Western tanager	casual	spring visitant
P. rubra	Summer tanager	common	summer resident
Cardinalis cardinalis	Cardinal	common	resident
Pheucticus ludovicianus	Rose-breasted grosbeak	common	transient
Guiraca caerulea	Blue grosbeak	very rare	summer resident
Passerina cyanea	Indigo bunting	casual to common	summer resident winter visitant

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Spisa americana	Dickcissel	rare to fairly common	summer resident
Hesperiphona vespertina	Evening grossbeak	rare to fairly common	winter resident
Carpodacus purpureus	Purple finch	uncommon to fairly common	winter resident
Acanthis flammea	common redpale	very rare	winter visitant
Spinus pinus	Pine siskin	rare to fairly common	winter resident
S. tristis	American goldfinch	common	resident
Loxia leucoptera	White-winged crossbill	rare	winter visitant
Pipilo erthrophthalmus	Rufus-sided towhee	common	resident
Passerculus sandwichensis	Savannah sparrow	common in migration, uncommon otherwise	resident
Ammodramus savannarum	Grasshopper sparrow	uncommon to common summer	summer resident winter visitant
A. henslowii	Henlow's sparrow	uncommon/rare	summer resident
Pooecetes gramineus	Vesper sparrow	uncommon to common in migration	transient and winter visitant
Chondestes grammacus	Lark sparrow	very rare	summer resident

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TABLE B-3 (continued)

LIST OF BIRDS WHICH HAVE BEEN REPORTED IN THE NORTH CENTRAL KENTUCKY REGION ACCORDING TO MONROE (UPDATED THROUGH 1976)

SCIENTIFIC NAME	COMMON NAME	RELATIVE ABUNDANCE	OCCURRENCE
Aimophila aestivalis	Backman's sparrow	rare	summer resident
Junco hyemalis	Dark-eyed junko	common	winter resident
Spizella arborea	Tree sparrow	uncommon to fairly common	winter resident
S. passerina	Chipping sparrow	casual to common	summer resident winter visitant
S. pusilla	Field sparrow	common	resident
Zonotrichia querula	Harris' sparrow	very rare	spring and winter visitant
Z. leucophrys	White-crowned sparrow	casual to common	winter resident summer visitant
Z. albicollis	White-throated sparrow	common	winter resident
Passerella iliaca	Fox sparrow	uncommon/rare	transient and winter visitant
Melospiza lincolnii	Lincoln's sparrow	uncommon/rare	transient and winter visitant
M. georgiana	Swamp sparrow	fairly common	winter resident
M. melodia	Song sparrow	common	resident
Calcarius lapponicus	Lapland longspur	rare	winter visitant
Plectrophenax nivalis	Snow bunting	very rare	winter visitant

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TABLE B-4

INVERTEBRATES COLLECTED FROM
THE WILSON CREEK WATERSHED (USEPA, 1979)

Taxa
Phylum Arthropoda
Crustacea
Decapoda
Cambarus sp.
Amphipoda
Gammarus sp.
Isopoda
Lirceus sp.
Insecta
Trichoptera
Limnephilidae sp.
Trichoptera sp.
Ephemeroptera sp.
Diptera
Tipula sp.
Phylum Mullusca
Gastropoda
Pulmonata
Physa sp.
Phylum Platyhelminthes
Turbellarid sp.

TABLE B-5

FISHES TYPICAL OF THE
SALT LICK, POND CREEK, WILSON CREEK
WATER SHEDS

Polydontidae
Paddle Fish *Polydon spathula*

Esocidae
Grass Pickeral *Esox americanus vermiculatus*

Petromyzonidae
Chestnut Lamprey *Ichthyomyzon castaneus*
Ohio River Lamprey *I. bdellium*
Least Brook Lamprey *Lampetra aepyptera*

Acipenseridae
Lake Sturgeon *Acipenser fulvescens*

Lepisosteidae
Longnose Gar *Lepisosteus osseus*

Amiidae
Bowfin *Amia calva*

Anquillidae
American Eel (females) *Anguilla rostrata*

Clupeidae
Gizzard Shad *Dorosoma cepedianum*
Threadfin Shad *D. petenense*

Hiodontidae
Goldeye *Hiodon alosoides*

Poeciliidae
Mosquitofish *Gambusia affinis*

Sciaenidae
Freshwater Drum *Aplodinotus grunniens*

Atherinidae
Brook Silverside *Labidesthes sicculus*

Percopsidae
Trout-perch *Percopsis omiscomaycus*

Cyprinodontidae
Blackstripe Topminnow *Fundulus notatus*
Blackspotted Topminnow *F. olivaceus*

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Amblyopsidae
Southern Cavefish Typhlichthys subterraneus

Aphredoderidae
Pirate Perch Aphredoderus sayanus

Ictaluridae
Blue Catfish Ictalurus furratus
Channel Catfish I. punctatus
Black Bullhead I. melas
Yellow Bullhead I. natalis
Flathead Catfish Pylodictis olivaris
Stonecat Noturus flavus
Mountain Madtom N. eleutherus
Brindled Madtom N. miurus
Margined Madtom N. insignis
Tadpole Madtom N. gyrinus

Cottidae
Banded Sculpin Cottus carolinae
Mottled Sculpin C. bairdi

Percichthyidae
White Bass Morone chrysops

Centrarchidae
Banded Pygmy Sunfish Elassoma zonatum
Largemouth Bass Micropterus salmoides
Smallmouth Bass M. dolomieui
Spotted Bass M. punctatus
Black Crappie Pomoxis nigromaculatus
White Crappie P. annularis
Rockbass Ambloplites rupestris
Warmouth Lepomis gulosus
Green Sunfish L. cyanellus
Bantam Sunfish L. symmetricus
Spotted Sunfish L. punctatus
Longear Sunfish L. megalotis
Bluegill L. macrochirus
Orangespotted Sunfish L. humilis
Pumpkinseed L. gibbosus
Redear Sunfish L. microlophus

Percidae
Yellow Perch Persa fluvescens
Walleye Stizostedion vitreum
Sauger S. canadense
Eastern Sand Darter Ammocrypta pellucida
Logperch Percina caprodes
Channel Darter P. copelandi
River Darter P. shumardi
Gilt Darter P. evides
Blackside Darter P. maculata
Dusky Darter P. sciera

Slenderhead Darter P. phoxocephala
Greenside Darter Etheostoma blennioides
Johnny Darter Ethrostoma nigrum
Variegate Darter E. variatum
Banded Darter E. zonale
Rainbow Darter E. caeruleum
Spotted Darter E. maculatum
Slough Darter E. gracile
Orangethroat Darter E. spectabile
Fantail Darter E. flabellare
Least Darter E. microperca

Catastomidae
Smallmouth Buffalo Ictiobus bubalus
Largemouth Buffalo Icyprinellus
Highfin Carpsucker Carpiodes velifer
River Carpsucker C. carpio
Lake Chubsucker Eromyzon sucetia
Creek Chubsucker E. oblongus
Hogsucker Hypentelium nigricans
Silver Redhorse Moxostoma anisurum
Shorthead Redhorse M. macrolepidotum
River Redhorse M. carinatum
Black Redhorse M. duquesnei
Golden Redhorse M. erythrurum
Greater Redhorse M. valenciennesi
White Sucker Catostomus commersoni

Cyprinidae
Carp Cyprinus carpio
Goldfish Carassius auratus
Stoneroller Campostoma anomalom
Blacknose Dace Rhinichthys atratulus
Longnose Dace R. cataractae
Suckermouth Minnow Phenacobius mirabilis
Creek Chub Semotilus atromaculatus
River Chub Nocomis

Telescope Shiner N. telescopus
Popeye Shiner N. ariommus
Rosyface Shiner N. rubellus
Emerald Shiner N. atherinoides
Blacknose Shiner N. heterolepis
Bigeye Shiner N. boops
Bigmouth Shiner N. dorsalis
Ghost Shiner N. buchanani
Spottail Shiner N. hudsonius
Central Common Shiner N. chrysocephalus

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APPENDIX C

PRESENTATION OF MODIFIED REMEDIAL ACTION ALTERNATIVE

JUNE 2, 1982

MODIFIED REMEDIAL ACTION ALTERNATIVE ANALYSIS

As a result of the request made at our meeting with Alex Barber, Barry Burrus and others of the KYDNREP on April 15, 1982 in Frankfort, Kentucky, we have prepared the following modified alternative to carry forward into conceptual design.

OBJECTIVE

This modified alternative is developed to meet the following objective in addition to the objectives and criteria presented in Chapter 2 of the feasibility study.

(1) Considering the cost and benefits of cleaning up the A. L. Taylor site a reasonable first year cost ceiling of $1 million will be used.

(2) The most serious reservoir of under ground wastes will be removed from the site.

(3) Site remedial design will be directed towards minimum operations and maintenance cost.

(4) Engineering design and selection of pollution control systems will be to minimum Kentucky Regulatory Standards.

The above objectives provide an acceptable level of control for the site. The levels of protection provided by this alternative is less than the Onsite-Containment or the Excavate-and-Relocate alternatives previously investigated. These previous alternatives provide the maximum protection from migration of the pollutants for their respective types of technology but not necessarily the most cost effective.

ALTERNATIVE DESCRIPTION

This alternative combines Onsite-Containment and Excavate-and-Relocate to provide a hybrid alternative compatable with Kentucky's goals. One approach considered was removing only the free liquid in the waste pits but was rejected for cost reasons. The approach recommended will remove the most toxic and highly polluted material on site. Other soils with lower levels of contamination will remain onsite. To prevent soil moisture, shallow ground water, and surface water from contacting these contaminated materials and acting as a transport medium both ground water and surface water diversion will be provided. Ground water diversion will be accomplished by a combination of upgradient slurry walls and french drains. Surface water diversion will be provided by a drainage way very similar to the ditch proposed in the Onsite-Containment alternative. In addition to diversion, a landfill cap will prevent vertical infiltration of rainwater into the contaminated zone. The landfill cap has been reduced in thickness from 3 feet to 2 feet of topsoil and clay. The site will be surrounded with a chain link fence and a locking gate for site security. After construction of this remedial action, monitoring wells will be installed between the site and Wilson Creek. The site layout of the Hybrid Alternative is presented in Figure 1.

Operation and maintenance requirements at the site have been kept to a minimum. Leachate collection requirements have been eliminated. Annual maintenance of the site will consist of repair of erosion damage, mowing and revegetation. Annual monitoring of the sampling wells will also be required.

ESTIMATED COST

The primary objective in developing the construction cost for this alternative was the upper limit of $1 million dollars. The cost of site closure was estimated and then the balance of the million dollar limit was used to estimate the volume of waste that could be removed or volume of free liquids which could be treated. The results are presented in Table 1 for construction costs and in Table 2 for annual operations and maintenance costs.

RESULTS

The cost of removing free liquids from the pits was too expensive to fit within the established budget. Furthermore, there is no assurance that these pits would not become saturated again 25 to 50 years in the future. For these reason the analysis of the modified alternative was direct toward a bulk removal approach.

The bulk removal approach is the same approach described in the Excavate-and-Relocate alternative. The amount of waste removed is about equal to the estimated volume material in the pit under the major magnetic anomaly identified in Figure 2. The range of material removed varies between 3600 and 5400 cubic yards. This volume of material is 50 to 100 percent of the material proposed to be removed under the Excavate-and-Relocate alternative. The free liquids encountered during the excavation will be mixed with the excavated material. Any excess liquid will be run through existing treatment plant.

TABLE 1

CONSTRUCTION COST ESTIMATE FOR ONSITE CONTAINMENT ALTERNATIVE

ITEM	COST, THOUSAND DOLLARS LOWER	UPPER
Slurry Wall	34	53
Clay Cap	41	68
Topsoil Cover	40	67
Drainage Diversion Channel	4	7
Monitoring Wells	8	13
French Drain	22	37
Removal of Existing Treatment Plant	5	6
Site Grooming, Clearing, Grubbing and Initial Revegetation	4	7
Security Fence, Gate, Signs	28	46
Utilities Installation	1	1
Record Plat	3	4
Project Management, Monitoring, Sampling and Permitting	40	60
SUB-TOTAL	230	369
Undefined Details and Contingencies (20%)	46	74
SUB-TOTAL	276	443
Excavate and Relocate	724	557
TOTAL	1,000	1,000

TABLE 2

FIRST YEAR OPERATION AND MAINTENANCE COSTS
FOR ONSITE CONTAINMENT ALTERNATIVE

ITEM	COST, THOUSAND DOLLARS LOWER	UPPER
Mowing, Reseeding, Fertilizing and Other Grounds Maintenance Activities	4	6
Grooming and Renovation of Drainage Channel	1	2
Groundwater Monitoring	12	20
SUB-TOTAL	17	28
Undefined Details and Contingencies (20%)	3	6
TOTAL	20	34

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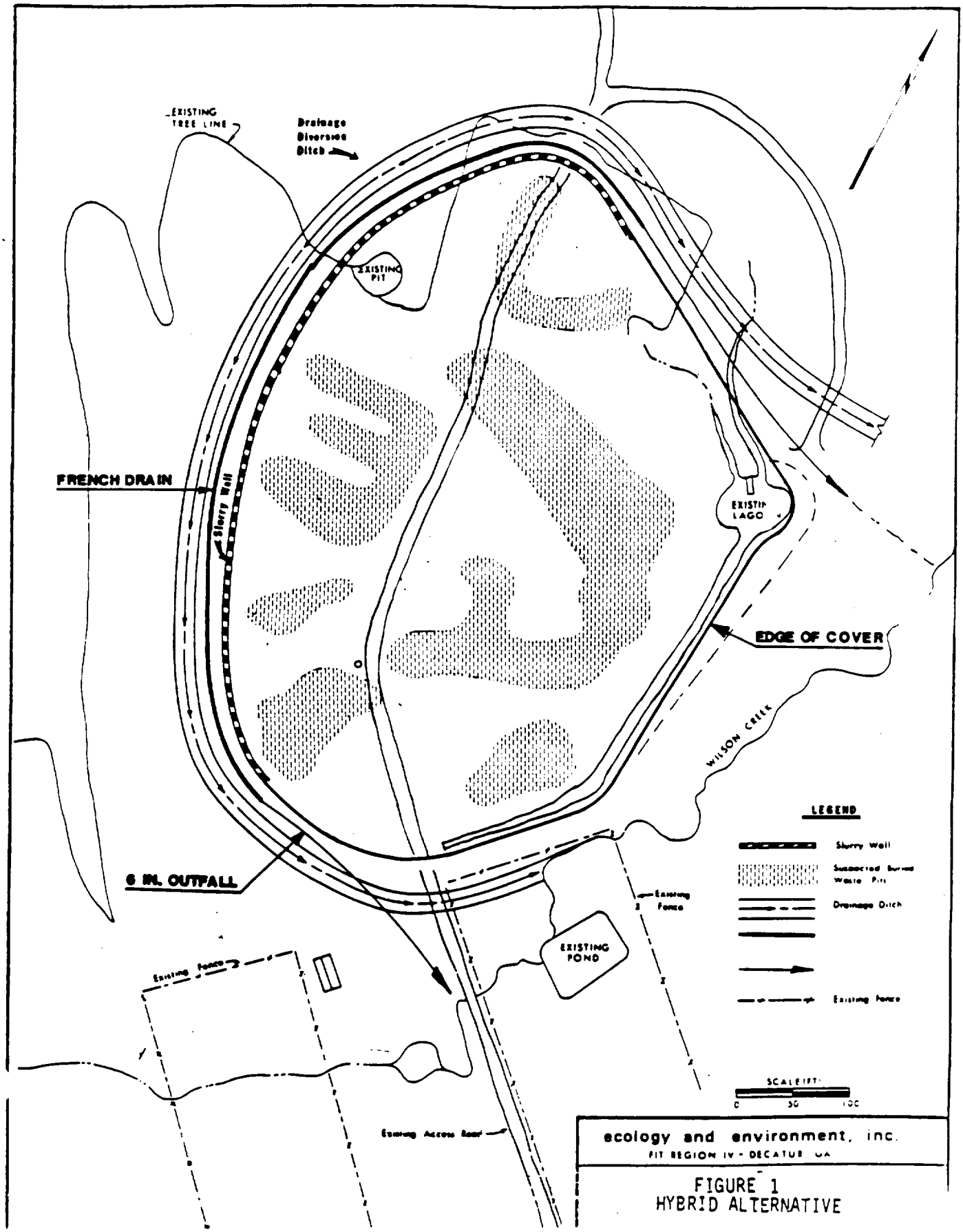

FIGURE 1
HYBRID ALTERNATIVE

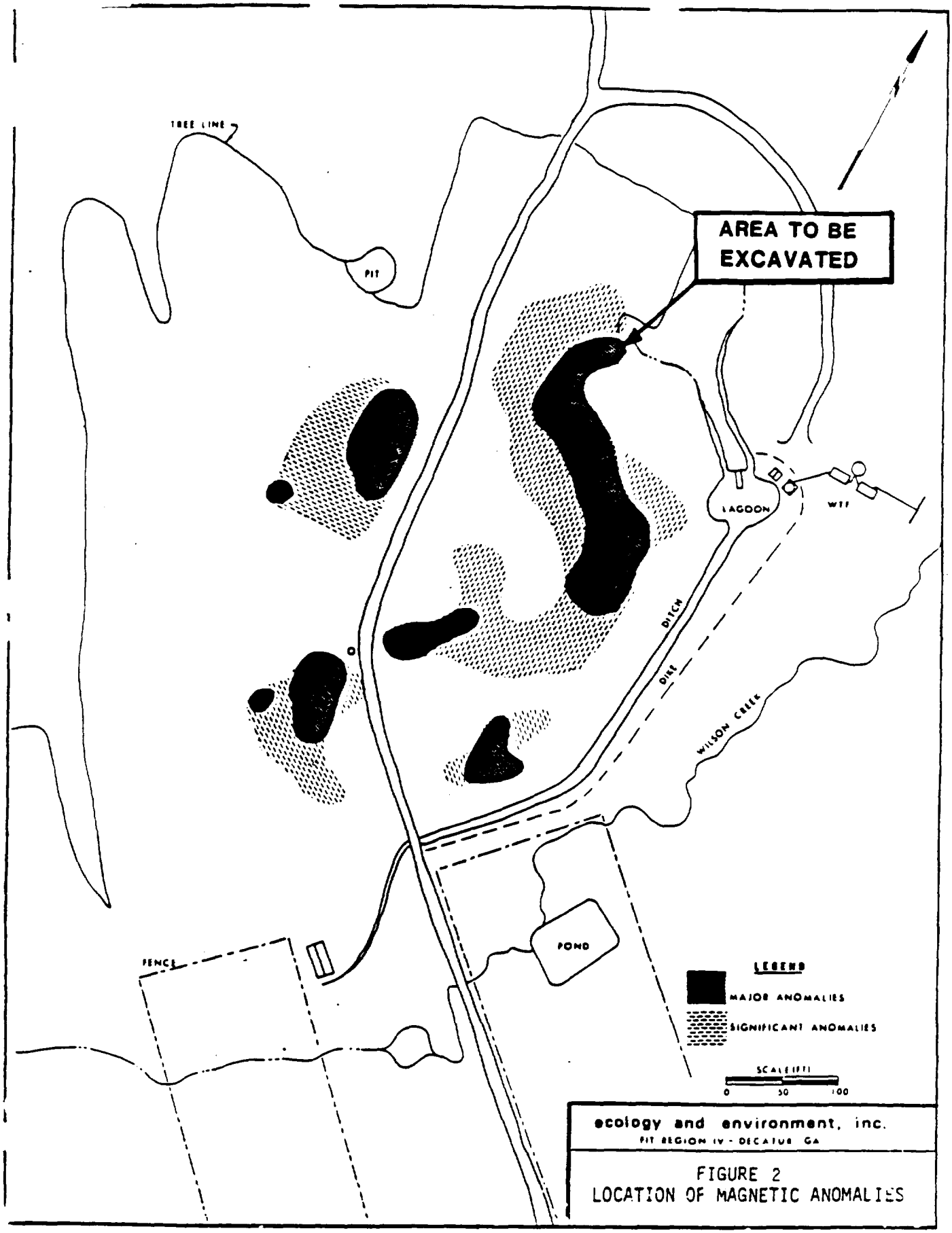

FIGURE 2
LOCATION OF MAGNETIC ANOMALIES

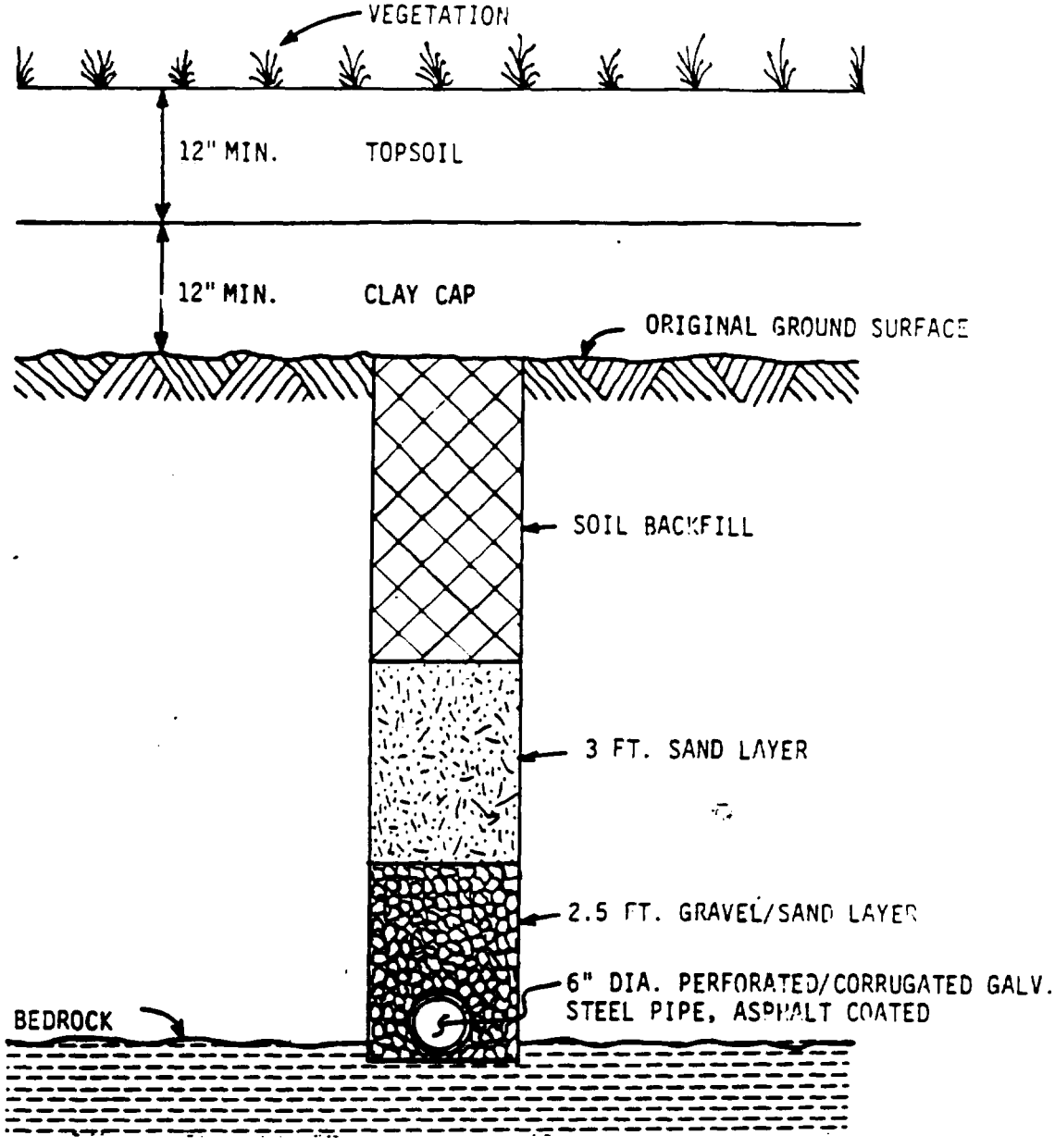

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FIGURE 3
TYPICAL CROSS-SECTION OF
FRENCH DRAIN

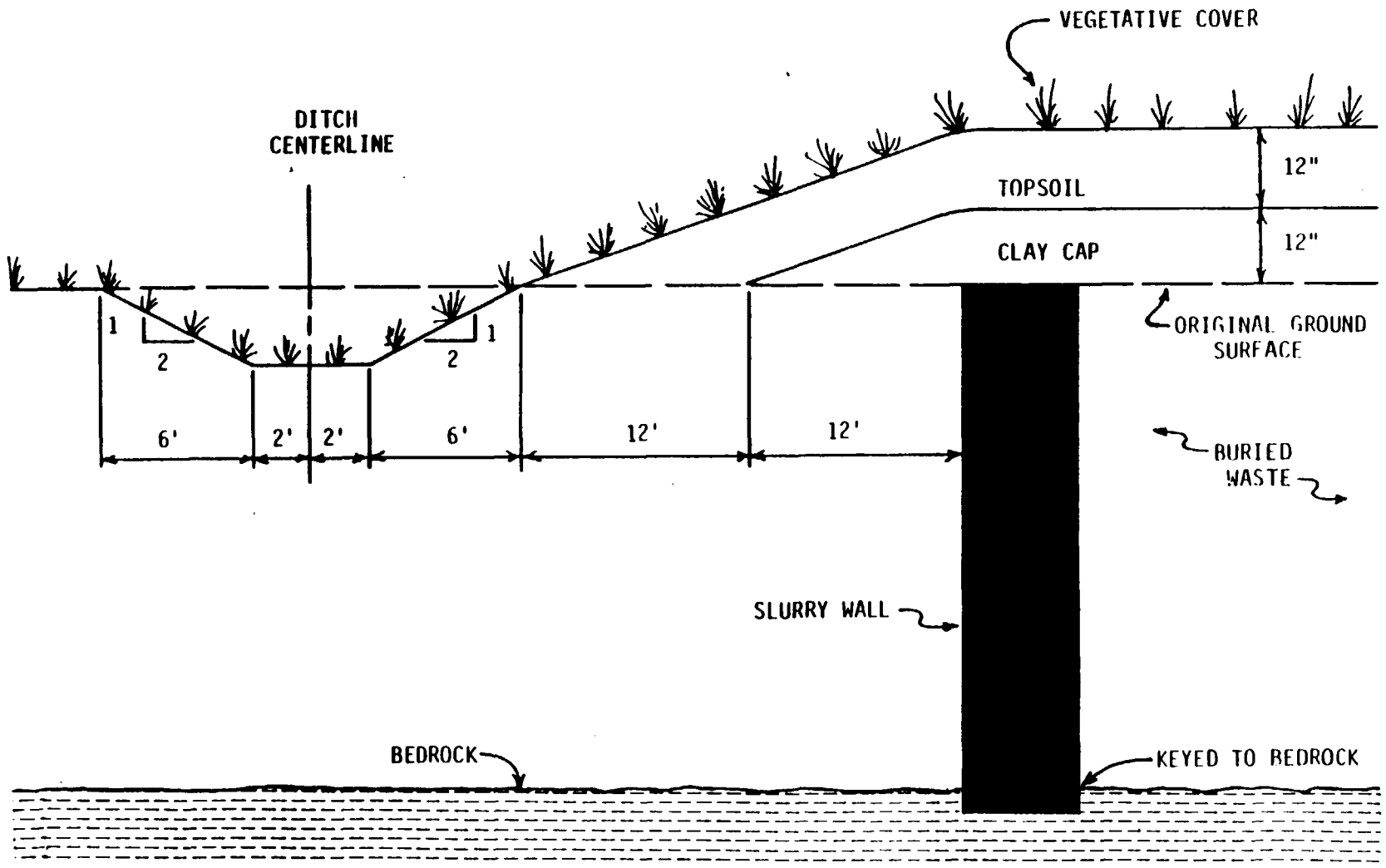

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FIGURE 4
TYPICAL CROSS-SECTION OF SLURRY WALL AND DRAINAGE CHANNEL

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I. INTRODUCTION

The A. L. Taylor site, also known as the "Valley of the Drums," is an uncontrolled and inactive hazardous waste disposal site located in Bullitt County, Kentucky. The site was recognized by the U.S. Environmental Protection Agency (EPA) as a high priority site for cleanup and, therefore, eligible for remedial action under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund Act). A history of response activities conducted to date at the site is summarized in the EPA document Feasibility Study of Remedial Alternatives for the A. L. Taylor Site prepared by Ecology and Environment, Inc. (E and E), dated September 23, 1982. The current status of the site is that all waste materials on the surface (drums of solid and/or liquid waste) have been removed and disposed of in a proper and safe manner, and final grading was performed. Subsequent to the cleanup and removal of waste stored on the surface of the site, it was estimated that 13,000 to 31,700 cubic yards of waste and contaminated soil remained buried at the site. The final step in the remedial action program was to establish an acceptable method for achieving closure of the site. The evaluations performed in the E and E study resulted in the recommendation that the on-site containment alternative be implemented for the A. L. Taylor site. The U. S. EPA, in conjunction with the Commonwealth of Kentucky, have concurred with this recommendation.

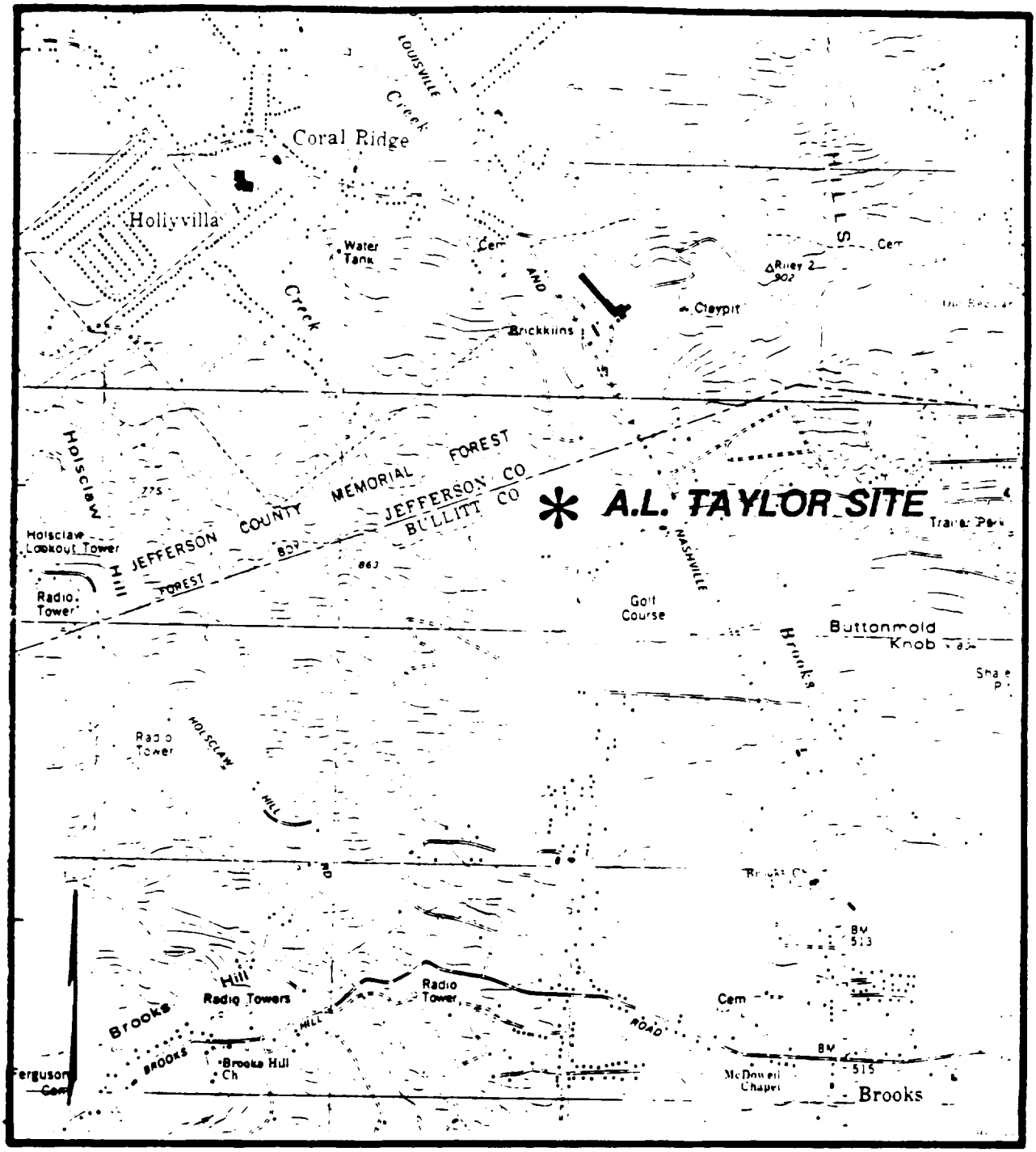
A. PURPOSE AND SCOPE

The purpose and scope of this design report is to define, evaluate, and design reasonable on-site containment of the waste and contaminated soils to achieve acceptable closure of the site. Acceptable closure is defined as the most cost-effective remedial actions that will protect the public health and welfare and the environment from the release of contaminants from the A. L. Taylor site. A major factor in determining the remedial actions that will achieve acceptable closure is the geotechnical characteristics of the site. Therefore, Section II of this design report will evaluate all geotechnical data, provided by the U.S. EPA, and will serve as input to the design of the proposed remedial actions.

B. SITE DESCRIPTION

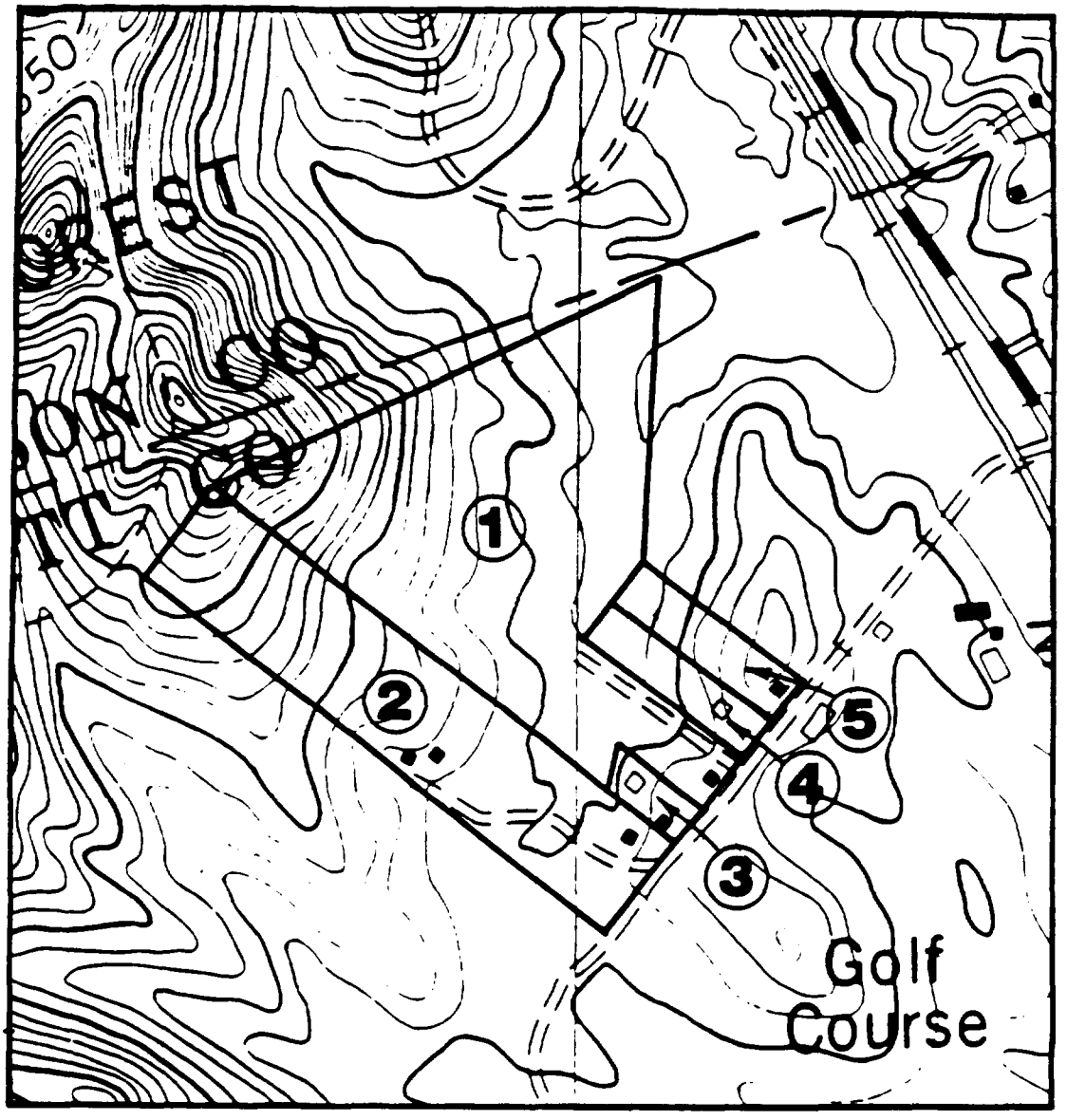
The A. L. Taylor site is located in Bullitt County, Kentucky, approximately 2,000 feet west of Kentucky Route 1020, just south of the Jefferson County line, just north of the Louisville and Nashville Golf Course, and less than two miles north of the community of Brooks, Kentucky (see Figure 1). Figure 2 shows the current property boundaries, owners, and acreages of the A. L. Taylor property and contiguous parcels.

Mr. Taylor originally owned a 23-acre tract of land where he operated a municipal refuse dump, a drum recycling center, and an industrial chemical dump for a ten-year period (1967 to 1977). Recent studies at the site (refer to the E and E feasibility study) have documented that less than five acres contain buried waste and contaminated soil. These identified waste cells are depicted in Figure 3.



Site Plan

FIGURE 1



1. A. L. TAYLOR	23.2 Ac.
2. JAMES PARSLEY AND ROY NICHOLS	11.5 Ac.
3. EVERETT H. COX	1.0 Ac.
4. JILLENE BOLT	2.0 Ac.
5. JILLENE M. OWEN AND RONALD D. OWEN	2.0 Ac.

FIGURE 2

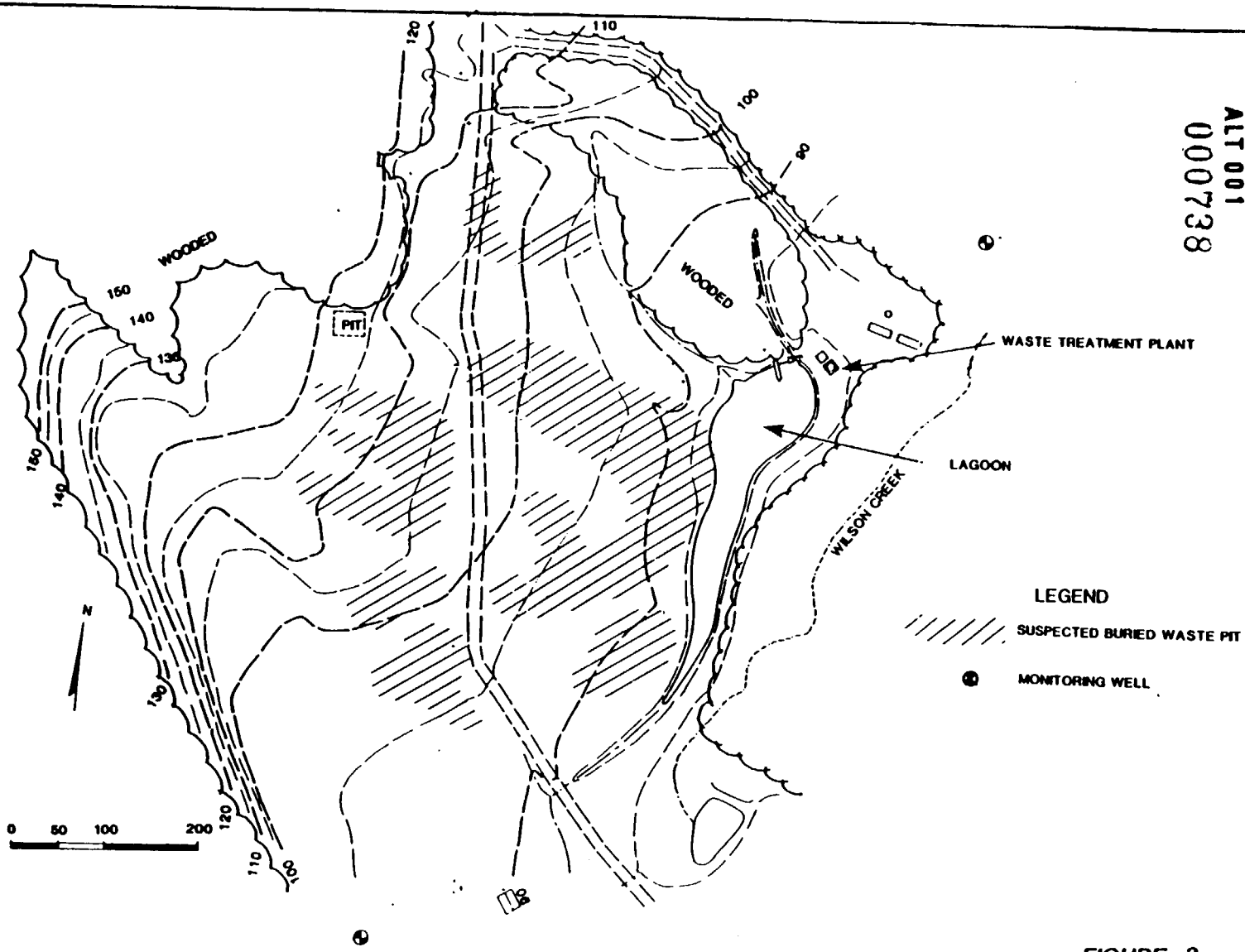


FIGURE 3

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C. OBJECTIVES OF THE PROPOSED REMEDIAL ACTION

The primary objective of the proposed remedial actions at the A. L. Taylor site is to achieve site closure in a manner that will accomplish the following goals in a cost-effective manner:

- Protect the public health and welfare and the environment
- Prevent migration of contained contaminants off-site
- Restore the site by regrading and revegetation
- Preclude access to the site by the general public

The remedial actions presented in this design report will be developed to achieve these goals with proper consideration given to the site's geotechnical characteristics and their overall cost effectiveness.

II. GEOTECHNICAL CHARACTERISTICS OF THE SITE

A. GENERAL SITE DESCRIPTION

The A. L. Taylor site is a 23-acre abandoned dump used for disposal of municipal trash and chemical industrial wastes. It is located in north-central Bullitt County, Kentucky, just south of the Jefferson County line. The site is located approximately 2,000 feet west of Kentucky Route 1020, South Park Road, and approximately 1,000 feet north of the Louisville and Nashville Golf Course. Access to the site is via Kentucky Route 1020 and a county road which runs along the northern side of the golf course. The turnoff for the county road is located approximately 900 feet south of the Jefferson County line and 2.6 miles south of the junction between South Park Road and Fairdale Road.

Extensive information is presently available regarding the environmental setting of the site in reports prepared by Ecology and Environment, Inc. (1982) and Technos, Inc. (1981). Other available information consists of published topographic maps, geologic maps, and soil surveys.

1. Topography

The A. L. Taylor site is located in the Knobs physiographic region of Kentucky. This region is characterized as a maturely dissected upland consisting of disjointed ridges and knobs of moderate relief. Maximum relief in the vicinity of the site is 300 feet, with elevations ranging from 840 feet to 540 feet above mean sea level (AMSL). Relief on the site is approximately 110 feet, with elevations ranging from 540 feet to 650 feet AMSL. Slopes on the sides of the hills at the site are concave in shape, being steeper near the tops of the hills. This configuration has resulted because the rock types occurring near the ridge tops are more resistant to erosion.

On the site, ground slopes range from 2 to 30 percent. Steeper slopes ranging from 20 to 30 percent are located near the top of the site on the northwest side. Along Wilson Creek, in the valley bottom below the site, ground slopes are very gentle and less than 10 percent. On natural undisturbed slopes, there is a smooth transition from the steeper slopes to the flatter slopes in the valley bottom. At the site, the natural slopes have been extensively disturbed by the excavation and grading activities which have occurred.

The A. L. Taylor site is located in the headwaters of Wilson Creek adjacent to a surface drainage divide. All runoff from the site enters Wilson Creek via small gullies or sheet flow over the ground surface. Flow in Wilson Creek is intermittent, occurring only during the wet seasons.

The A. L. Taylor site is located on the Brooks quadrangle, 7.5-minute series, topographic map. It is located at 85°43'27" west longitude, 38°04'56" north latitude. Both the regional and site topography can be seen on that map.

2. Geology

Rocks outcropping in the vicinity of the site range in age from Middle Silurian through Mississippian. Rock types outcropping in the area are sedimentary in origin, being predominantly shales with some limestone, dolomite, and siltstones occurring. The basic information on site geology is provided by the geologic map of the Brooks Quadrangle (GQ-961), published in 1972 by the Kentucky Geological Survey.

The site is situated on and underlain in stratigraphic order (top to bottom) by the New Providence shale, New Albany shale, and Louisville limestone. The New Providence shale is the principal surficial rock unit at the site. As mapped, this unit comprises the base of the ridge and floors the valley bottom under Wilson Creek. The contact between the New Providence and the New Albany shales is located at approximate elevation 480 feet AMSL. Elevations along Wilson Creek are 540 feet AMSL which indicates that there is approximately 40 to 50 feet of New Providence shale under the valley bottom. The New Providence shale is greenish gray to olive gray in color and weathers to a light gray or yellowish gray in color. Total mapped thickness of the New Providence shale in the vicinity of the site is 140 feet.

The New Albany shale, also known as the black shale, underlays the New Providence. Total thickness of the shale is mapped as ranging from 73 to 94 feet. It is olive black to grayish black in color and is massive and dense in fresh exposures. The Louisville limestone underlays the black shale.

Regional geologic structure in the area of the A. L. Taylor site is that of a relatively flat and uniform dip to the west. The approximate rate of dip is 90 feet per mile, with the strike of the strata being approximately due north. On the geologic map, the structural contours are drawn on the top of the New Albany shale. In the immediate area of the site, there are no mapped faults or other structural deformities.

3. Soils

Soils at the A. L. Taylor site are residual in origin, having been formed by weathering of the rock strata. The Soil Conservation Service has mapped the surficial soils and published a soil survey for Jefferson County. Mapping of the surficial soils is presently in progress for Bullitt County. Due to the close proximity to mapped areas in Jefferson County (500 to 1,000 feet), the surficial soil types can easily be inferred for the site. The soils have been mapped using the Textural Classification System normally used for agricultural purposes. The predominant soil type at the site is silt loam with a profile thickness of as much as 3.5 to 4.5 feet. Utilizing the Unified Soil Classification System normally used for engineering purposes, a classification of CL would result which is a clay of low plasticity.

Soils on the lower valley slopes and the valley bottom are of the Zanesville series which are characteristic of the Knobs region. Zanesville soils are silt loams formed from loess and residuum derived from sandstone and shale. Slopes range from 2 to 20 percent. These soils are moderately well drained, but vertical movement of groundwater may be restricted by the fragipan found in the lower Zanesville soils.

Soils occurring on the ridges and upper hill slopes are of the Litz-Muskingum complex. These soils classify as silt loams which are shallow and are somewhat excessively drained. They occur on steep slopes, having been formed as residuum derived from siltstones, shales, and sandstones. These soils occupy slopes ranging from 20 to 50 percent.

Surficial slumping has occurred at the base of many of the ridges. In these areas, the Zanesville series will consist of colluvial material which has collected at the base of the hill. At the site, slumping cannot be identified due to the extensive surface disturbance.

Surface soils on the site area have been significantly altered by excavation and grading during operation and emergency cleanup activities. As a result, there is little topsoil remaining.

B. SITE INVESTIGATIONS

Investigations have been conducted on the A. L. Taylor site on numerous occasions beginning in 1979. Objectives of these studies have been to evaluate levels of contamination of soil and water, locate areas where buried drums and liquid wastes are present, characterize the subsurface features at the site, determine soil and rock properties, and locate zones of groundwater seepage. Information from these studies has been used to identify and delineate the problems at the site and was used to support the design of the remedial actions for the site.

Investigation of the site was begun during the spring of 1979 during the first emergency cleanup action. The U.S. EPA collected soil, surface runoff, and groundwater samples for the purposes of detecting and measuring the levels of contaminants. Analysis of these samples indicated the presence of a wide variety of organic compounds and heavy metals. This investigation included augering eight holes and excavation of ten small pits with a backhoe. These activities provided the first information concerning the soils and near surface geology of the site. Laboratory testing identified contaminants and the extent of their migration. Information from this study is available in a nine-page report dated March, 1979.

The first geotechnical study was conducted in the spring of 1981 by Technos. It was principally a geophysical study using magnetometer readings, metal detection, resistivity measurements, and seismic methods. The objective of this study was to locate and determine the areal extent of waste pits, buried drums, and leachate plumes. Five major burial areas were located and delineated on the site (refer to Figure 3). The top of unweathered bedrock, New Providence shale, was estimated to range from 12 to 30 feet below the land surface. Technos reported that, from their study, no evidence of fractures in the shale or other stratigraphic anomalies were found. A report was prepared on the geophysical studies and submitted to EPA and E and E in May, 1981.

During December of 1981 and January of 1982, the second site investigation was undertaken by E and E. The purpose of their study was to establish engineering criteria for cleanup alternatives by more closely defining the geohydrologic characteristics of the site. Information was sought in this

study to determine elevations of groundwater tables and the rate along with direction of groundwater flow. Information from these field studies is documented in reports prepared by E and E dated September, 1982, and December, 1982.

Sixteen resistivity soundings were made at the site as part of the E and E study. Fourteen 100-foot soundings, one 30-foot sounding, and one 300-foot sounding were made. Verification of the shallow portion of the sounding was obtained based on borings performed near the sounding location.

Seventeen 6-inch diameter borings were made to refusal on bedrock. Depths of these holes ranged from 3.5 to 29 feet. During the drilling, undisturbed soil samples were obtained for laboratory analysis using a Shelby tube sampler. In the holes which remained, open water level readings were taken for a several-day period following completion of the hole. During drilling, only slightly damp soils were penetrated; and no free-flowing water was noted. Water did seep into most of the holes over a several-day period. Locations of the borings performed and resistivity soundings are shown in Figure 4.

During November of 1982, a third field investigation took place at the site. Two groundwater wells, ALDW-1 and ALDW-2, were installed just outside the site boundaries. The purpose of these wells, as stated in a letter to EPA dated December 14, 1982, from E and E, was to determine subsurface stratigraphy. The information to be obtained included thicknesses of formations, presence and nature of fractures, and permeability of subsurface strata. With this information, conclusions could be drawn about the potential for off-site migration of contaminants. Locations of the two wells drilled are shown in Figure 4.

Information collected during these site investigations comprises the existing geotechnical and geohydrologic data base for the A. L. Taylor site. There appears to have been adequate data collected to characterize the soils, geology, and groundwater regime at the site.

C. SUBSURFACE INVESTIGATIONS AND RESULTS

During previous subsurface investigations at the site performed by E and E and Technos, locations of geophysical survey points and borings were established on a grid system. Relative locations were of these borings and soundings were established from the drawings in available reports and were taken into account during design.

1. Locations of Buried Wastes and Contaminants

Investigations to locate the buried wastes were conducted by both Technos and E and E. Geophysical techniques were used by both for the purposes of locating buried drums and waste pits. A magnetometer system utilized by Technos provided the capacity to detect buried ferrous objects.

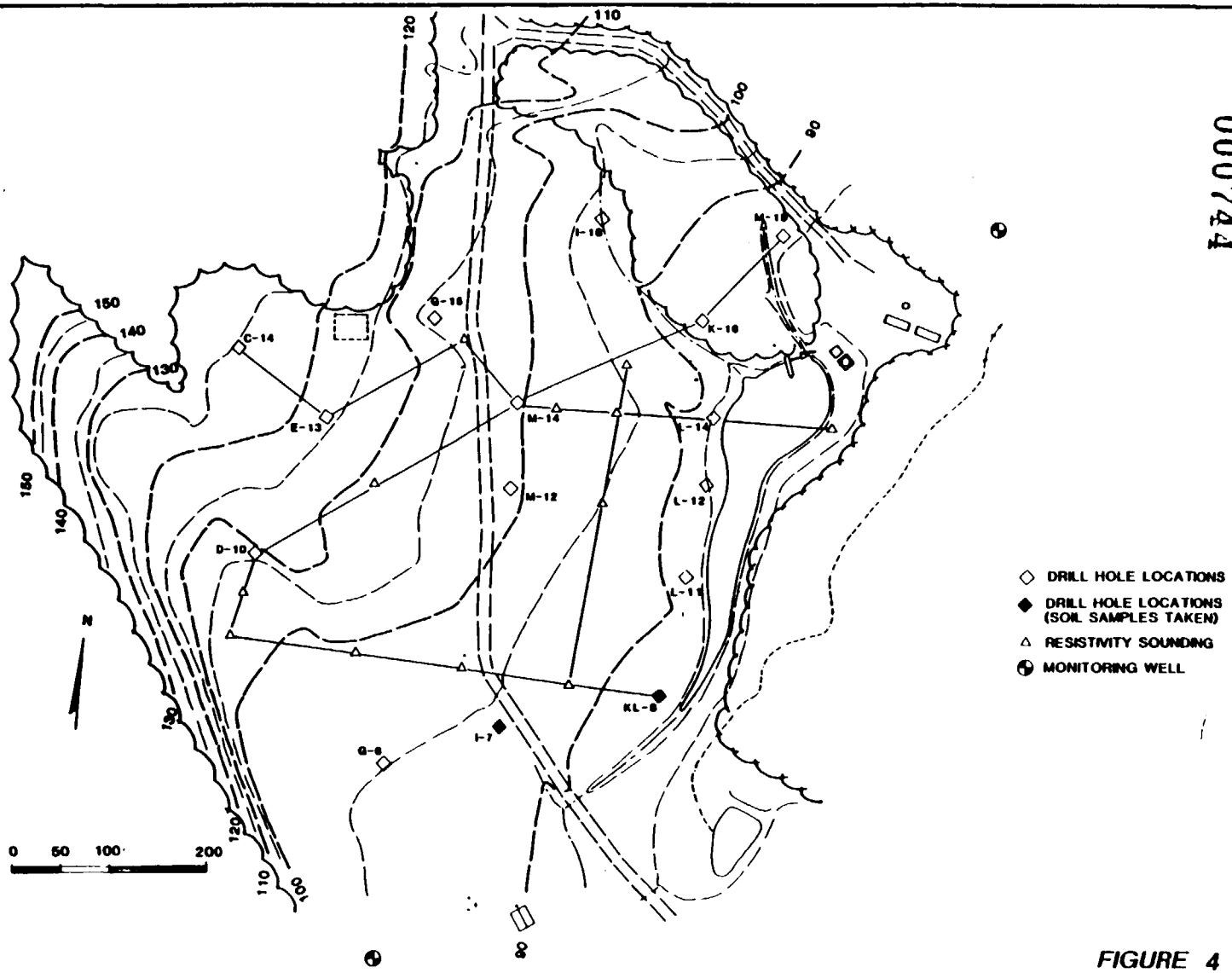

FIGURE 4

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Metal detectors provided a check on the magnetometer data as well as the capability of detecting nonferrous metal objects. The electromagnetic survey conducted provided a measure of the subsurface conductivity. By comparing and correlating the data from these surveys, the locations of buried wastes were determined.

Electromagnetic and magnetometer data correlated very well in the detection of buried steel materials. A total of four possible trench-like features were detected as well as two large areas containing several significant isolated anomalies. In addition, a conductivity plume was detected emanating from the liquid disposal pit on the north end of the site. By compiling these data, the locations of buried wastes and drums were located. Figure 3 presents the compiled data locating the waste trenches. Details of the surveys, survey data, and drawings from which Figure 3 was compiled are given in reports by Technos, 1981, and E and E, 1982.

2. Soils and Site Stratigraphy

Resistivity, seismic, and boring data comprise the subsurface information available on soils at the site and stratigraphy. Both E and E and Technos conducted resistivity surveys; seismic refraction surveys were conducted only by Technos.

Resistivity survey data comprise a significant portion of the data available. Conclusions drawn from that data by E and E in their September, 1982, report are as follows:

- Soil ranges from 15 to 25 feet thick (in most places 20 feet) and is mostly clay.
- The top of bedrock, therefore, is at about 20 feet below the land surface.
- There is little groundwater in the clay above the shale. Most water above bedrock occurs as soil moisture.
- There are some water-bearing fractures in the New Providence shale. These are nearly horizontal and may be fractures, faults, or bedding plane partings. They occur 30 to 35 feet below land surface, may range in length up to several hundred feet, and are probably less than 50 feet wide. The fractures are likely discontinuous. The fractures appear to be localized and do not extend over the entire area of the site. Also, they do not appear to have a vertical component which could facilitate downward transmission of groundwater and contaminants into bedrock.
- An inflection is indicated on most soundings at 80 to 90 feet below land surface. This may be the contact between the New Providence and the New Albany shales, and this contact zone appears to contain water in some places. Previous soundings, as well as the geologic literature, suggest that the New Providence shale is about 60 feet thick at the site which corresponds to the feature detected by resistivity soundings. The literature further indicates that the New Albany

shale probably occurs from 100- to 160-foot depths. Below it is an approximate 90-foot thickness of the Louisville limestone which is underlain by the Waldron shale.

The seismic refraction surveys were conducted in the north and western portions of the A. L. Taylor site. A seismic refraction survey establishes the subsurface geometry based on compression wave velocities in the materials. Three layers of material were identified at the site. These materials and their compression wave (P-wave) velocities are as follows:

Surface Clays	1,200 - 1,500 ft/sec
Weathered Shale	3,000 - 5,000 ft/sec
Unweathered Shale	8,000 - 9,000 ft/sec

The measured velocities of the upper two layers showed an acceptable data scatter indicating nonhomogeneous material. The weathered and unweathered shale showed an adequate velocity contrast to establish confidence in the calculated depths to unweathered shale.

In the northern area of the site, the weathered-unweathered shale approaches the ground surface, or outcrops, along the north end and approaches a depth of 20 feet on the southeast end.

The weathered-unweathered shale interface dips significantly to the south-southeast in the northern area of the site, while the bedding planes of the shale are essentially horizontal. This interface appears to be controlled by the original topography of the area. The site has been reworked extensively; the result is that an observed dip appears for the seismic data on the unweathered shale surface relative to the existing ground line.

In the southwestern area of the site, the surface clay material ranges from 1 to 7 feet thick. Weathered shale varies from 7 to 20+ feet thick. Depth to the unweathered shale varies from 12 to 30 feet, generally increasing in depth from north to south.

Results and interpretations of the seismic survey data are contained in the Technos May, 1982, report. Maps showing the locations of the surveys and diagrams presenting the results are in that report.

During December of 1981 and January of 1982, 16 auger borings were made to determine soil depths and thickness of weathered shale and to obtain samples of soils for testing. The locations of the borings are presented in Figure 4, and the drillers log for each hole is contained in Appendix 1 of this report. Thicknesses of soil and weathered shale varied considerably between auger holes. In some locations, the drillers and geologist were unable to distinguish between soil and weathered shale.

The 16 auger borings ranged in depth from 3.5 to 29 feet. Five of the borings were dry, and water level measurements were taken from ten of the others. The deeper borings occurred closer to Wilson Creek, and the shallower borings occurred at the higher elevations. Correspondingly, more of the holes were dry at the higher elevations than at the lower elevations along Wilson Creek. During drilling, only slightly damp soils were encoun-

tered; and no free-flowing water was noted in the drill holes. Water did seep slowly into most of the holes which were drilled. Based on these observations and water level measurements in the holes, it can be concluded that a groundwater regime does exist in the soil and weathered shale.

Undisturbed soil samples were collected and laboratory tested from several of the borings. Results of the testing are reported in Table 4-12 of the E and E September, 1982, report. To summarize the results, the soils are classified as CL and ML soils. They are of moderate plasticity, with PI's ranging from 12 to 20. Permeability tests were conducted, and results ranged from 4.33×10^{-7} to 9.37×10^{-8} feet per minute. These coefficient of permeability values indicate that soils on the site are essentially impermeable.

A more detailed discussion of the auger borings and soil testing appears in the E and E December, 1982, report. In general, the soils at the site have desirable characteristics with regard to being utilized for waste disposal. They are very good in impeding water percolation and gas migration and they have excellent properties for use as a landfill cover.

3. Bedrock Geology and Hydrologic Characteristics

Information with regard to the depth to bedrock and thicknesses of weathered shale has been provided by the resistivity and seismic surveys discussed previously. General information on bedrock geology has been provided by the geologic map of the Brook Quadrangle and has been summarized in the introduction to this report. Two deep borings were made in the fall of 1982 by E and E in order to investigate and confirm both stratigraphy and hydrologic conditions.

The two deep wells, ALDW-1 and ALDW-2 (refer to Figure 4), investigated the bedrock stratigraphy and permeability. ALDW-1 is located on the southeastern side of the site and penetrated to a depth of 200.8 feet below the land surface. It penetrated the soil, the New Providence and New Albany shales, and 77.1 feet of the Louisville limestone. ALDW-2 is located southwest of the site and penetrated to a depth of 71.2 feet, with the final 6.1 feet of the hole being in the top of the New Albany shale. Generalized drill logs for each of these wells are given in Table 1. They are summarized from field logs provided by EPA. In the drill logs, no fractured zones or jointing was identified. Bedding planes and laminations within the strata were noted, but no vertical fractures were observed.

Pressure permeability tests were run in well ALDW-1. To perform these tests, two expandable pressure packers were utilized. They were separated by a distance of 5 feet in the hole. The area of hole between the two packers was subjected to water under pressure, and the water loss into bedrock was noted. Data from these tests were provided to TenEch by EPA. Pressure testing was not conducted in ALDW-2.

The first zone tested was between 36 and 41 feet in depth at the contact between the New Providence and New Albany shales. Water pressures of 18 and

TABLE 1

GENERALIZED DRILL LOGS
WELLS ALDW-1 AND ALDW-2

Log for Well ALDW-1

Depth Below LSD (feet)	Thickness (feet)	Sample Description	Remarks
0 - 25.0	25.0	Green clay; stiff and dry	
25.0 - 38.2	13.0	Weathered gray New Providence shale; horizontal bedding plane	
38.2 - 123.7	85.5	New Albany shale; black, massive, pyritic	
123.7 - 200.8	77.1	Louisville limestone; gray, vuggy, pyritic, fossiliferous	Water level 43.95 feet BLS

Log for Well ALDW-2

Depth Below LSD (feet)	Thickness (feet)	Sample Description	Remarks
0 - 17.0	17.0	Green clay; stiff and dry	
17.0 - 65.1	48.1	New Providence shale; gray, weathered, dry; some horizontal fractures 48-51 feet	
65.1 - 71.2	6.1	New Albany shale; black massive, pyritic; zone of horizontal fractures at 70-71 feet	Three days after drilling, flushing, and pumping out drilling liquid, well had not recharged.

36 psi were placed on that zone. Water loss into that zone ranged from 1.6 to 2.0 gallons per minute at 18 psi and 7.0 to 7.4 gallons per minute at 36 psi. To determine the permeability of this zone, equations given on page 195 in Design of Small Dams by the Bureau of Reclamation, 1973, were used. For the test run at 18 psi, the permeability was determined to be 3.96×10^{-4} feet per minute. For the 36 psi test, a value of 9.56×10^{-4} feet per minute resulted. For the purposes of these calculations, it was assumed that the pressure applied was at the top of the hole; and the elevation head associated with the water standing in the drill rod should be added to obtain the total head acting on the test zone. In the data supplied by EPA on the testing, the pressure head factor was not clearly explained.

The second zone tested was between 50 and 55 feet in depth. This zone was located within the New Albany shale. No water loss occurred at an applied pressure of 36 psi. At that point within the shale, the strata could be considered to be impermeable.

The third zone tested was also within the New Albany shale between the depths of 63 and 68 feet in the drill hole. Water losses did occur in this interval at an applied pressure of 32 psi. The maximum water loss was 0.3 gallons in one minute. The permeability of this zone based on the water loss is 2.7×10^{-5} feet per minute. This value indicates that, for that particular zone, the permeability is low.

It should be noted when reviewing these test data that these tests were run at unnaturally high water pressures. Also, assumptions were made regarding the total head on the test zone when making the calculations of permeability. The principal conclusion which can be drawn is that permeability of the bedrock strata is low; and, in some areas, it is impermeable. Based on the fact that no vertical fractures were located in the core, the permeability measured by the pressure tests is that along the bedding planes and is, therefore, the horizontal permeability of the strata.

The following narrative summarizes the available information on both the New Providence shale and the New Albany shale.

The New Providence shale is a gray to greenish gray clay shale. At the site it underlays the soil on the hill slopes and valley bottom. Total thickness of the shale layer ranges from 210 to 270 feet as mapped on the Brooks 7.5-minute geologic map. Along Wilson Creek at well ALDW-1, 13 feet of New Providence shale is present under the soil layer and above the contact with the New Albany shale. Horizontal fractures along bedding planes have been noted in the New Providence, but vertical fracturing or joints with which groundwater movement could be associated have not been noted. Pressure testing which was conducted principally evaluated horizontal permeability along bedding planes and found it to be moderate to low.

The New Albany shale is a massive, dense, black oil shale which underlays the entire area. Total thickness of the shale is approximately 73 to 94 feet as mapped on the Brooks 7.5-minute geologic map. The Louisville limestone underlays the New Albany shale. Pressure testing to determine permeability indicated that the shale is essentially impermeable.

A generalized stratigraphic section for the A. L. Taylor site is shown in Figure 5.

4. Groundwater

Two zones containing groundwater have been identified during field work performed at the site. The first zone is in the soil overburden and weathered shale layer. The occurrence of this water is sporadic as indicated by the auger borings which were obtained. Some holes were dry and remained dry; water collected in other holes over a period of several days. Water which did enter the holes rose to a level of several feet from the bottom. The maximum rise recorded over a several-day period was approximately seven feet. Table 2 presents the observations obtained regarding the occurrence of water and its elevation within the holes created by the auger borings. These observations, along with the low coefficients of permeability determined from laboratory testing, indicate that movement of water through the soil and weathered shale is extremely slow and sporadic. All borings into the New Providence shale encountered relatively dry material, and no water was noted in the drill logs. It is, therefore, reasonable to assume that the water which is occurring in the soil is perched on the unweathered shale.

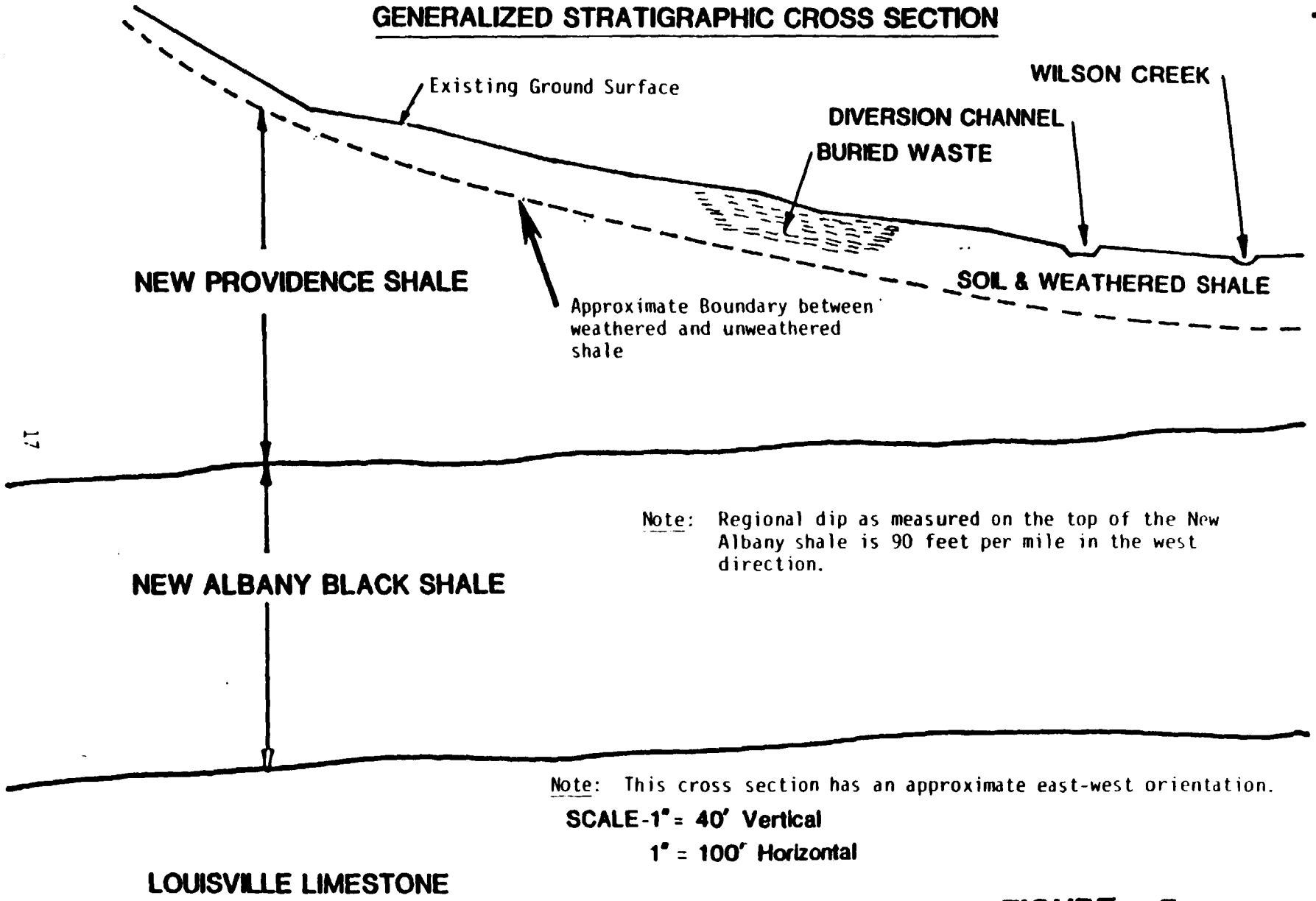
Groundwater movement in the soil and weathered shale will occur in a horizontal direction due to the impermeable shale underlaying the soil. Based on the observed elevations of water in the auger holes, it would be expected that movement will occur parallel to the bedrock surfaces which is approximately parallel to the existing land surface. The direction of groundwater movement would, therefore, be toward Wilson Creek.

The second significant water-bearing zone is located in the Louisville limestone. Water was not present in ALDW-2 which penetrated the top of the New Albany shale. After pumping out the drill water, this hole did not recharge over a several-day period. From this information, it can be concluded that water was not present in the New Providence shale or along its contact with the New Albany shale. Water was recovered by pumping from ALDW-1 from a depth of 77.1 feet into the Louisville limestone, with the pump located at a depth of 200 feet. Water was being pumped from the well at a rate of 3.5 gallons per minute, and the water level in the well was drawn down to just above the pump.

Along the Jefferson-Bullitt county line in the area of the A. L. Taylor site, the freshwater-saline water interface has been mapped by the Kentucky Geological Survey to be between elevations 400 and 500 feet AMSL. The top of the Louisville limestone in well ALDW-1 is at elevation 400.3 feet AMSL. Therefore, the water being pumped from the limestone layer was probably saline in nature. Consequently, it can be concluded that water in the Louisville limestone is very likely unsuitable for most uses and definitely unsuitable for human consumption.

Vertical movement of groundwater in rock strata is principally through vertical joints and fractures. Neither vertical fractures nor joints were noted in the core samples obtained from wells ALDW-1 or ALDW-2. With the

GENERALIZED STRATIGRAPHIC CROSS SECTION



Note: Regional dip as measured on the top of the New Albany shale is 90 feet per mile in the west direction.

Note: This cross section has an approximate east-west orientation.

SCALE-1" = 40' Vertical

1" = 100' Horizontal

FIGURE 5

TABLE 2

WATER LEVEL MEASUREMENTS FROM BOREHOLES
AT THE A. L. TAYLOR SITE

WATER LEVEL IN FEET ABOVE MEAN SEA LEVEL ON DATE GIVEN

Well	Surface Elevation	12-09-81	12-10-81	12-11-81	1-05-82	1-06-82	1-07-82
01		537.6				539.5	
E-13	563	548.8	550.9		555.6	555.6	555.6
M-19	544	Dry	Dry	Dry			
C-14		Abandoned					
I-18	545		534.0		540.7		
F-21		Dry	Dry	Dry			
H-14	552			542.5			
L-11	537				535.3	535.8	
L-14	536				529.3	526.4	
L-12	537				531.2	533.1	
K-16	540				533.1		
G-6	542					536.5	536.4
I-7	542					536.6	536.6
H-12	551					Dry	Dry
KL-8	536					Dry	Dry
G-15	557					Dry	Dry
D-9						Dry	Dry

rock types occurring at the site being shale, intergranular movement of groundwater is extremely limited. The shales underlaying the site can, therefore, be considered to be impermeable.

In a letter dated December 14, 1982, from E and E to EPA, results and conclusions drawn from the well drilling and testing in November, 1982, were presented. The following paragraphs were taken from that letter:

"Due to the following reasons:

- Lack of any vertical fracturing
- Tightness of clays
- Limited amount of water accepted by fractures in pressure tests
- Lack of water in overburden

it is very unlikely that contaminants would migrate offsite. The lack of ground water in the soil overburden eliminates a medium for transporting contaminants. If substantial ground water was present, migration would most likely occur laterally only, though the extremely tight soils would probably preclude even that. Based on conditions observed during drilling, the likeliest horizon for water to occur is at the contact between the two shale units. However, no water of a measurable quantity was encountered at this zone during drilling.

Drilling and coring at both locations revealed no vertical component of fracturing. This, in combination with an approximate 85-foot thickness of massive New Albany Shale at the site would make vertical migration of contaminants into the underlying Louisville Limestone highly improbable.

The Louisville Limestone in the vicinity of the site contains very limited quantities of water, yielding less than five gal/min. The water is brackish. Analytical data when received will indicate actual salinity. Therefore, based on the findings from this drilling project, it appears that it is not likely that contaminants will migrate vertically at all and horizontal migration would be minimal. Also, the Louisville Limestone at the site is not considered an aquifer, since the water occurs in very small quantity and is not potable."

A generalized summary of the groundwater regime at the A. L. Taylor site is presented in Figure 6. This figure consists of a generalized cross section showing the subsurface strata, groundwater zones, and corresponding directions of movement.

4. Cover Material

A hazardous waste landfill cover serves three purposes. First, it prevents rainwater from infiltrating the wastefill area and contributing to the potential generation of leachate. Secondly, the cover serves as a barrier to control potential gas migration. The third purpose of a cover is to prevent contamination of runoff by direct contact with waste materials and contaminated soils. Where adequate thicknesses of clay type soils of low permeability exist, the native soils can be utilized as a cover material.

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GENERALIZED SUMMARY OF GROUND WATER REGIME

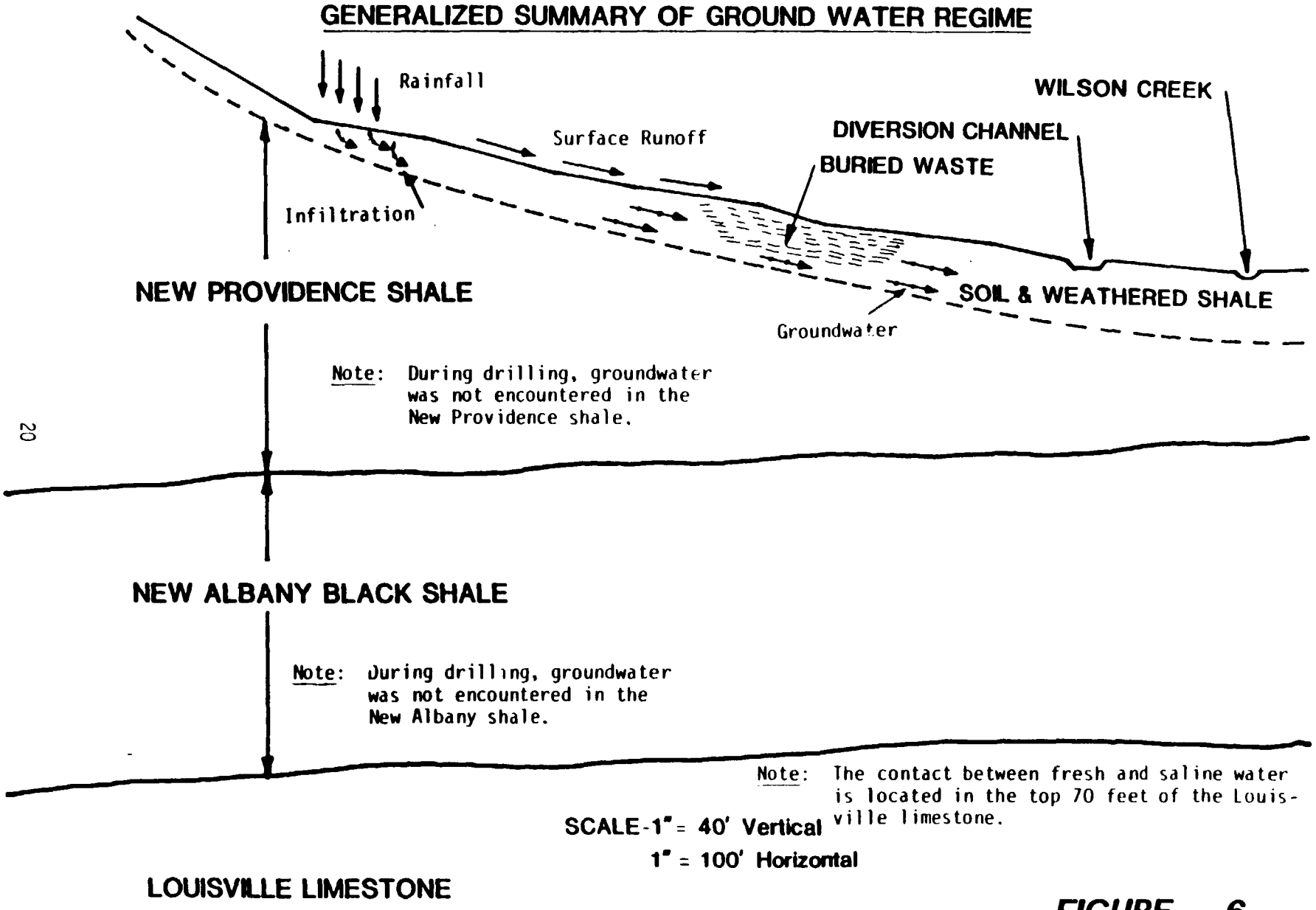

FIGURE 6

At the A. L. Taylor site, the natural soils have been disturbed extensively; and the original ground contour modified. On the upper slopes of the site, soils and weathered shale have been pushed downslope to cover the buried waste. In those areas, the New Providence shale is exposed. Only on the steep upper slopes above the tree line are undisturbed soils present. The predominant soil type occurring is silt loam which has a profile thickness of three to four feet. These silt loams classify as ML or CL by the Unified Soil Classification System and A-6 or A-7 by the ASSHTO System. Typical engineering properties for compacted soils are given in Table 9-1 of the Navfac DM-7 Manual. The native soils at the site are classified as ML or CL, and their properties can be found in that table. The properties of principal concern regarding the A. L. Taylor site are permeability and density. If the native soils were excavated and compacted to form a cover over the site, they could be expected to have the following properties.

Maximum Dry Density	95 to 120 pcf
Optimum Moisture	12 to 24 percent
Coefficient of Permeability	10^{-5} to 10^{-7} feet per minute

Test data for the surficial soils presented in the E and E September, 1982, report indicate that their properties are such that they would be suitable for a cover material. If these soils were used as a cover, significant additional surface disturbance would be required to obtain an adequate volume of material. Excavating and utilizing the existing cover soils over the buried waste cells is undesirable as it may be contaminated.

The New Providence shale is a potential source for cover material. It is known to be an argillaceous shale which weathers rapidly. On construction projects where excavations are being made into the shale, it is usually ripped with a dozer. When exposed to weathering, it degrades rapidly into a soil-like material. With proper handling, the shale could possibly be used as the cover material. When broken down, it has soil characteristics; and the properties may be adequate for it to be used as the cover.

To evaluate the suitability of the New Providence for a cover material, it will be necessary to sample and test for its properties. Unweathered samples of shale should be obtained either by pit excavation or by core drilling. Slake durability tests should be performed on the unweathered samples. These tests evaluate through empirical correlation how a rock will break down due to compactive effort during construction and/or weathering. A minimum of three of these tests should be run to evaluate how well the shale will break down into a soil-like material. A second set of unweathered samples should be mechanically broken down to a maximum size suitable for performing a moisture-density test. A minimum of three of these tests should be run to evaluate the compactibility of the shale. On completion of the moisture-density testing, material from those tests should have the following list of tests performed:

Gradation:	Sieve Analysis	ASTM D422
	Hydrometer	ASTM D422

Specific Gravity:		ASTM D854
Atterberg Limits:	Liquid Limit	ASTM D423
	Plastic Limit	ASTM D424
	Shrinkage Limit	ASTM D427

Results of these tests can be used to characterize the shale after compaction into the cover over the site.

The coefficient of permeability of the compacted shale should be on the order of 10^{-7} feet per minute. To evaluate the permeability, it is recommended that three compacted samples be prepared for permeability testing. Results of the moisture-density test should be used to determine the moisture content to be used for compaction of the test sample. Compaction should preferably take place in the permeameter. Once the sample is set up for testing, it should be subjected to a constant head test beginning at a pressure of 0.5 psi. Additional pressure increments should be added according to the outflow from the permeameter. Also, a falling head test should be performed to confirm results.

Results of the testing program to determine physical characteristics along with compaction and permeability properties would be used to evaluate the suitability of excavated and compacted New Providence shale for cover over the site.

It has been estimated that approximately 17,000 cubic yards of material will be required to place the impermeable cover 18 inches thick over the site. To obtain this volume of cover, it would be necessary to excavate an area 400 feet long by 200 feet wide to a depth of approximately 6 feet. Also, the topsoil from the excavation area could be used to place on the impermeable cover. Areas which may be suitable for this excavation is located along the eastern and/or western side of the A. L. Taylor site.

The fact that clay shales such as the New Providence break down into soil-like materials has been recognized for a number of years. The Federal Highway Administration has funded an investigation of the performance of clay shales used in highway embankments. In a series of research reports, the last of which was published in December, 1978, the engineering properties were established and construction procedures recommended for utilization of these shales in embankments. If the New Providence is suitable for utilization as the cover, guidelines set forth in Volume 5, Design and Construction of Compacted Shale Embankments, December, 1978, should be followed for construction of the cover. Areas specifically addressed in the guidelines are excavation techniques, compactive effort required, and lift thickness. Due to the specialized application of the shale at this site, it will be necessary to utilize three 6-inch thick lifts. This will be necessary to ensure breakdown of the shale and provide a multiple layer configuration for the cover. The multiple layer approach would ensure that a weak or thin spot in one layer would be covered by the next layer above.

Utilization of the New Providence shale for the impermeable cover would be a cost-effective way to obtain cover material. If clay was trucked into the site, it would most likely come from the clay pit located at the brick

company on Kentucky Route 1020, north of the site. The source of clay at the brick company is from the horizon of the New Providence shale.

5. Topsoil

As part of the cover system for the A. L. Taylor site, a 6-inch thick layer of topsoil is proposed. The availability of topsoil at the site is limited due to the extensive surface disturbance which has occurred. The estimated volume of topsoil required to cover the site with a 6-inch thick layer is approximately 5,600 cubic yards. To obtain this volume of required material, it will be necessary to disturb additional area. To obtain the required soil from an excavation 400 feet long and 200 feet wide, it will be necessary to excavate to a depth of about 2 feet. Soil profile thicknesses for the Zanesville series soils are adequate to provide the required volume.

The Zanesville series soils occupy the slopes at the base of the hills at the site. Total soil profile thickness for the Zanesville ranges from 30 to 40 inches. The best available material for the topsoil cover is the B horizon of the existing undisturbed soils at the site. Soil materials in the B horizon classify as a silty clay loam. A description of the profile for the Zanesville silt loam taken from the Jefferson County Soil Survey is as follows:

- Ap - 0 to 7 inches, brown (10YR 4/3) silt loam; moderate, fine and medium, granular structure; friable; slightly acid; gradual, smooth boundary; 6 to 9 inches thick.

- B21 - 7 to 18 inches; brown (7.5YR 4/4) or strong-brown (7.5YR 5/6) heavy silt loam; moderate, medium, subangullar blocky structure; friable; several small, black concretions; strongly acid; gradual, smooth boundary; 9 to 13 inches thick.

- B22 - 18 to 20 inches; brown (7.5YR 4/4) silty clay loam; moderate, medium, subangular blocky structure; firm; several clay films; many small, black concretions; very strongly acid; clear, smooth boundary; 8 to 14 inches thick.

- B3m - 29 to 40 inches+; yellowish-brown (10YR 5/6) silty clay loam; common, medium, faint, grayish-brown (10YR 5/2) mottles and common, medium, distinct, gray (10YR 6/1) mottles; moderate, medium, and coarse, angular blocky structure; firm; compact and brittle; very strongly acid.

It will be necessary to verify the profile thickness in potential borrow areas surrounding the site.

Some enhancement will be necessary for the B horizon soils to establish plant growth. Testing should be performed on samples of the soil to determine the need for lime and fertilizer. Tests to be performed are as follows.

SMP Buffer pH
Available Potassium

Available Phosphorus
Available Nitrogen

Results of these tests, will establish lime and fertilizer requirements.

If adequate volumes of natural topsoil are not available, the New Providence shale should be evaluated as a topsoil substitute since it is highly probable that the shale can be utilized as a topsoil substitute. A portion of the testing to evaluate the shale for a cover material will apply to utilizing it as a topsoil substitute. Additional tests which will be required to evaluate it as a topsoil substitute are as follow:

SMP Buffer pH
Potential Acidity
Available Potassium
Available Phosphorus
Available Nitrogen

Results of these tests, along with particle size gradations, will allow the evaluation of the shale.

The soil pH is the most useful criterion for predicting the capacity of a soil to support vegetation. Not only is plant growth affected by pH, but inferences can also be made about other quantities. An example is the availability of some plant nutrients to plants in soils that are moderately acid (pH 5.5) to slightly alkaline (pH 8.5).

Factors to be considered in evaluating the shale for a topsoil substitute are given in numerous publications related to coal mine reclamation. For this evaluation, guidelines given in A Guide for Revegetating Coal Mine Soils in the Eastern United States, by Willis G. Vogel, 1981, are being used as a general guide.

6. Leachate Generation and Movement

Of principal concern at the A. L. Taylor site is the contamination of groundwater and its movement. Sufficient data have been collected to characterize the groundwater regime at the site. Two groundwater zones have been located: a shallow zone in the soil and weathered shale and a deep zone in the Louisville limestone. Data collected on groundwater and its movement have been obtained by observing water elevations in auger holes and in the two deep wells which were drilled. Observations of water elevations in drill holes were made for only a short period of time. Long-term monitoring of water levels has not been conducted. Therefore, the available data do not reflect seasonal variations since the testng was performed during the months of December and January.

Analysis of water and soil samples taken from test holes drilled on the site has shown contamination of the shallow groundwater under the site. This was reported in the E and E 1982 report. Most of the test borings were located in close proximity to the waste cells where contamination most likely would have occurred. Locations of these borings are shown in Figure 4.

Two aquifers have been identified at the A. L. Taylor site. The first is a shallow aquifer located in the soil and weathered shale near the ground surface. A deep aquifer located in the Louisville limestone is the second zone. The shallow aquifer can be considered a perched aquifer. The areal extent and subsurface geometry of this aquifer are determined by the local topography and areal extent of the New Providence shale. Unweathered New Providence shale is an aquiclude which prevents the vertical movement of water. Available data indicate that the New Providence shale is not jointed, and vertical fractures are not present. Therefore, secondary permeability does not exist in the shale. Both the New Providence shale and New Albany shale are present between the shallow aquifer and deep aquifer. The New Albany shale is a dense, massive black shale of low permeability. Data indicate that jointing and vertical fractures are not present in the New Albany shale. At the site, there is a minimum thickness of 110 feet of unweathered New Providence and New Albany shales separating the shallow and deep aquifers. Contamination of the deep aquifer is, therefore, highly improbable.

Waste materials at the A. L. Taylor site are buried in excavations made in the soil and weathered shale layer. Therefore, the wastes are essentially buried in the shallow aquifer. The shallow aquifer can best be described as an unconfined aquifer located in unconsolidated to semiconsolidated residual material. Thickness and depth of this shallow aquifer vary from 3 to 30 feet. The water level within the aquifer varies; but, in general, it can be expected to follow the topography of the ground surfaces (at a depth of several feet below the surface). Likewise, the bottom of the aquifer can be expected to also follow the shape of the ground surface.

Recharge of the shallow aquifer takes place due to infiltration and percolation of rain water. The slopes of the hill above the site and the site itself are the principal areas for recharge. Soils on the upper slopes are thinner; and, therefore, a lesser volume of infiltrating water will be utilized as soil moisture. The areal extent of the recharge area is limited by the local topography.

The direction of groundwater movement can be expected to be in a downslope, down-gradient direction of movement toward Wilson Creek. This direction of movement is supported by the observed elevations of water in the auger borings.

Leachate generation is directly related to the amount of rainfall which infiltrates the ground surface to become groundwater. A procedure for estimating leachate generation is given in a publication entitled Use of the Water Balance Method for Predicting Leachate Generation from Solid Waste Disposal Sites, EPA, 1975. This method relates the factors of precipitation, runoff, evapotranspiration, soil moisture storage, and infiltration to determine the amount of annual rainfall which penetrates the ground as percolation. A water balance calculation has been made for the A. L. Taylor site. The soils at the site are clay soils which tend to increase the volume of runoff. Slopes at the site average 5 percent and greater and also tend to increase the volume of runoff. Clay and clay loam soils also have a high field storage capacity for moisture which will tend to reduce percolation. With these factors taken into account and assuming a one-meter thickness of

soil over the entire site, waste disposal area, and recharge area, water balance calculations were made. The precipitation values used for each month were the mean annual values occurring at the weather station located at Standiford Field in Louisville. Results for the calculations were that little or no percolation would occur during a year when normal rainfall amounts occurred (refer to Section III for details relative to the water balance calculations). Grading and other site disturbances have altered the conditions from those described above and enhanced infiltration potential at the site. However, implementation of the proposed remedial actions will result in a site condition superior to the original state of the site and would make the site even less susceptible to surface water infiltration and percolation.

An estimate of leachate production can be obtained based on the water levels observed in borings, the measured permeability of the soils and the equation for groundwater flow, $Q = KiA$, Darcy's Law. In this equation Q is the rate of flow, K is the permeability, i is the hydraulic gradient and A is the cross sectional area of flow. Assuming that the soil is homogeneous and continuous, the measured coefficient of permeability of 4.33×10^{-7} feet per minute applies. A value for A can be approximated based on the observed water level in the borings and an assumed width of the zone of groundwater movement of 500 feet along the lower side of the site. The water level in one hole rose seven feet above the bottom of the hole. Using a flow width of 500 feet and a saturated zone thickness of seven feet a value for A of 3,500 square feet is obtained. The hydraulic gradient at the site cannot be determined precisely due to the variability of water level between holes. The worst case condition would be a value of 1.0 and the least case condition would be approximated by the existing ground slope, which is six percent on the lower side of the site. For the worst case condition a value of 5,958 gallons per year is obtained, and for the least case condition a value of 358 gallons per year is obtained. Drilling information in the form of dry holes indicates that groundwater is not moving at all points along the lower side of the site, and the values calculated above represent upper and lower bound estimates of leachate generation.

The mode of movement of groundwater in the soil at the site could be either through the intergranular spaces in the soil or along small established flow channels: fissures in soil and weathered shale. If the soils and shales are homogeneous and continuous, the rate of flow will be controlled by the permeability of the soil and weathered shale. Testing of the soils established the permeability as 4.33×10^{-7} feet per minute; this corresponds to a flow rate of 0.27 feet per year. The closest waste cell to the creek is approximately 70 feet away. Based on the above calculated flow rate, the earliest that contaminated groundwater could reach Wilson Creek is approximately 260 years; and it could take as long as 4,300 years.

The estimations of potential leachate generation and subsequent movement presented above are based upon numerous assumptions relative to the sites subsurface conditions. The most significant assumptions are those for cross sectional area of flow, hydraulic gradient, and mode of movement.

III. PROPOSED REMEDIAL ACTIONS

The purpose of this section is to present the proposed remedial actions for the provision of on-site containment for the buried waste and contaminated soil located at the A. L. Taylor site. The design of these remedial actions is predicated upon the evaluations of available geotechnical data presented in Section II and the application of professional engineering practice. The proposed remedial actions consist of the following major components: an impermeable cap and soil cover; a drainage diversion ditch; a monitoring well system; site clearing, regrading, and revegetation; security fences and signs; and record plat. A conceptual layout of the proposed remedial actions is presented in Figure 7 and the following discussion presents a detailed description of its various components.

A. IMPERMEABLE CAP AND SOIL COVER

The impermeable cap and soil cover component of the proposed remedial actions serves two essential functions for providing on-site containment of the waste cells. The impermeable cap prevents the downward percolation of surface water into the waste cells, while the soil cover provides a medium for vegetative cover to prevent erosion and to protect the impermeable cap. Numerous factors must be evaluated and considered when designing a cover for a hazardous waste disposal site. The U.S. EPA has published numerous technical and guidance manuals that document design, evaluation, and construction procedures for covers. Relative to the design of the cover for the A. L. Taylor site, the U.S. EPA publication SW-867, Evaluating Cover Systems for Solid and Hazardous Waste, dated September, 1982, was utilized extensively. Design considerations presented in this document were reviewed and applied, where appropriate, to the cover design for the A. L. Taylor site.

1. Soils and Soil Data

The existing soils at the site have been identified and discussed in the preceding section of this report. Available test results have characterized the soils at the site and have indicated that existing soils should be suitable for use as a cover material.

Additionally, the New Providence shale present at the site should be usable as a cover material due to its clay-like nature, its tendency to break down into a soil-like material, and our previous experience in working with this material. The shale will be sampled and tested to determine its properties and suitability. If suitable, the shale will require special excavation and compaction techniques to provide a suitable cover for the site.

Presently, the exact source of the material for the cover has not been determined. Therefore, it will be necessary for the selected cover material to be tested to confirm its properties and provide the necessary information to establish the required construction techniques. Tests which will need to be performed on the selected cover material can be summarized as follows:

Graduation Analysis	ASTM D421 D422 D2217
Atterberg Limits	ASTM D423 D424 D427
Specific Gravity	ASTM D854
Soil Classification	ASTM D2487
Compaction	ASTM D698 (modified to 15 blows/layer)
Permeability	ASTM D2434

For design purposes, it has been assumed that existing soils from the site will be utilized as the selected cover material or a material very similar to the existing soils. The construction controls and/or procedures contained in the specifications may need to be modified based upon results from the tests performed on the selected cover material.

2. Site Topography

The A. L. Taylor site is located at the base of a hill on a rolling topography with slopes ranging from less than 1% to a maximum of slightly greater than 15%. A topographic map of the site was developed for purposes of development and design of the proposed remedial actions. The site plan sheet contained in the construction drawings presents the existing site topography. Cross sections are also included to characterize and delineate the site topography.

Review of the site plan and cross sections reveals that there are no steep slopes or areas where significant fill embankments exist. Within the area to be overlain by the cover, the existing ground surface is rolling with only a few minor irregularities.

At the extremeties of the cover, a maximum slope of 4 to 1 is proposed. Across the northern portion of the cover, the maximum slope will be that of the existing ground surface (approximately 14%). The remainder of the proposed cover will possess slopes in the range of 5% to 11%.

Based on site topographic conditions with respect to natural slopes and fill slopes, neither slope stability or severe erosion problems are anticipated. The slopes across the site have the desirable characteristics of providing for runoff which will limit infiltration of rain water.

The contour on the surface of the cover will generally follow the contour of the existing ground surface. Only in a few areas will it be necessary to grade the existing ground surface to remove irregularities. The cover to be placed over the waste area has a uniform cross section and thickness. With the site topography being that of a relatively uniform

rolling slope, there is little variation in the geometry of the cover across the site. Therefore, only the site plan and a limited number of cross sections are required to depict the site geometry and contour of the cover to be placed over the site.

3. Cover Composition and Thickness

It is proposed that the cover for the A. L. Taylor site consists of on-site soils or soil-like material. These soils classify as ML or CL soils according to the Unified Soil Classification System. The two principal objectives of the cover for the site are to provide for rapid runoff of rainfall and to limit infiltration through the cover into the buried waste cells. The ML and CL soils existing at the site possess desirable characteristics and properties with regard to the stated objectives for the cover.

The areal extent of the cover has been determined based on available information regarding the locations of buried waste trenches. Significant volumes of information were available regarding these locations. That information was presented previously in this report and was extensively utilized in the design of the cover.

The only source of water for infiltration at the site is rainfall. Therefore, an evaluation of the local water balance, with respect to the cover, is essential for design of the cover. The closest weather station to the A. L. Taylor site, which has a significant length of record, is the Louisville WSFD station located in Jefferson County. This station has 46 years of temperature and precipitation data available.

Three water balance calculations have been made for the A. L. Taylor site. The first calculation is for what can be considered the undisturbed, prewaste disposal water balance. Existing conditions at the site are approximated in the second calculation, which assumes a thin soil cover over the buried waste. The third calculation considers the water balance for the site with the proposed remedial actions in place. Details and assumptions for each calculation are included in Appendix 2, along with the water balance table for each calculation. Climatological data and evapotranspiration calculations are also included in that appendix. Summaries for the water balance calculations for the three situations analyzed are as follows:

- Water Balance - Prewaste Disposal Conditions - The following assumptions and parameter selections were made for purposes of the calculations:

  - Soils at the site are clay loams and have an average thickness of 36 inches over the site.
  - Runoff coefficients are 0.35 for wet seasons when soil moisture contents are high and 0.24 for dry seasons.
  - Soil moisture storage capacity at field capacity is 375 mm per meter of soil depth. The capacity for 36 inches of soil is 343 mm.

  Based on these assumptions, an annual rainfall of 1,095 mm will result in 328.9 mm runoff, 747.8 mm of evapotranspiration, and 18.3

mm of percolation which would be available for groundwater recharge. These results indicate that little or no recharge of the groundwater system was occurring at the site. A near-balanced condition appears to have existed between infiltration, soil mositure storage capacity, and evapotranspiration. Only during periods of above average rainfall would water potentially percolate into the groundwater system.

- Water Balance - Existing Site Conditions - The following assumptions and parameter selections were made for purposes of the calculations:

  - Soils at the site are clay loams.
  - The thickness of soil cover over the waste trenches is one foot.
  - The runoff coefficient for the site is 0.28. No consideration is given to wet and dry seasons due to the lack of vegetation on the site.
  - Soil moisture storage capacity at field capacity is 375 mm/meter of soil depth. The capacity for 12 inches of soil is 114 mm.

  Based on these assumptions, an annual rainfall of 1,095 mm will result in 306.5 mm of runoff, 575.7 mm of evapotranspiration, and 212.8 mm of percolation. The existing site condition has increased percolation over the preexisting conditons; and, therefore, potentially increased the volume of water moving through the shallow aquifer.

- Water Balance - Proposed Remedial Actions - The following assumptions and parameter selections were made for purposes of the calculations:

  - The type of soil used for the cover is clay loam.
  - The cover has an effective thickness of 30 inches consisting of 6 inches of compacted, existing, in-place soil; 18 inches of additional soil, placed and compacted; and 6 inches of topsoil to provide for a vegetative cover.
  - Runoff coefficients return to those prewaste disposal conditions (0.35 for wet seasons and 0.24 for dry seasons).
  - Soil moisture storage at field capacity is 375 mm per meter of soil depth. Actual capacity for the 30 inches of soil comprising the cover is 285 mm.

  Based on these assumptions, an annual rainfall of 1,095 mm will result in 328.9 mm of runoff, 705.6 mm of evapotranspiration, and 60.5 mm of percolation through the cover on the site. Results of these calculations indicate that for a cover consisting of two feet of material, percolation is reduced significantly and the water balance at the site is returned to essentially prewaste disposal conditions.

These water balance calculations indicate that little or no percolation of water will occur with the proposed cover in place at the site. Presently, all except one of the waste pits are covered with soil. With the addition of two additional feet of soil placed and compacted over the site, an adequate thickness of soil should exist over the buried waste to extremely limit, if

not totally eliminate, percolation of water from the surface into the site. Therefore, the volume of leachate generated at the A. L. Taylor site is expected to be minimal or nonexistent as a result of percolation of rainfall. It should be noted that the only water available for percolation is that which falls directly on the site, as all off-site runoff will be diverted around the site.

The average annual depth of frost penetration as reported in the Asphalt Institutes' Soil Manual (MS-10), March, 1978, is 10 inches. The proposed cover thickness is 24 inches and will be adequate to prevent frost penetration through the cover. Cracking due to moisture loss will be controlled by a vegetative cover.

Gas migration was not considered as a factor in the cover design since gas producing decomposition and/or chemical reactions should not be occurring at the site.

4. Cover Placement and Configuration

The adequacy of cover placement and compaction procedures determines the effectiveness of the cover in achieving its objectives. Therefore, careful consideration needs to be employed during design and construction to ensure proper cover installation.

Preparation of the ground surface prior to placement of the cover is very important. Steps which need to be taken, and the reasons for taking them, can be summarized as follows:

- All vegetation needs to be cut and removed from the area where the cover is to be placed.
- The area to be covered should be graded prior to placement of the cover to eliminate irregularities in cover thickness. Small gullies and low areas should be filled to eliminate potential ponding areas.
- To prepare the existing in-place soils for cover placement and to utilize these in-place soils as a component of the cover system, the surface should be graded and then disked to a depth of 6 inches to loosen the soils. These in-place soils should then be compacted to form a suitable base for the cover and to increase its effectiveness. If necessary, water should be incorporated during disking to facilitate compaction. There shall be no specific density requirement for this process other than a minimum number of passes for the compaction equipment.

The surface preparation, along with compaction of the existing surface, should provide a firm base upon which placement of the cover can commence. If waste materials are close to the surface and create soft spots where the weight of construction equipment causes deformations in the surface, these locations will become evident during compaction of the existing soils. If these soft spots are severe enough in nature to require remedial actions (such as placement of engineering fabric and thickening of the cover), those

actions could be taken prior to initiating the placement of cover material over the entire area.

The cover is to be placed and compacted in layers. To ensure adequate compaction, six inch thick lifts should be used. This lift thickness is a relatively standard construction practice which should pose no special problems to a contractor. Efforts should be made to ensure a uniform lift thickness.

Compaction of soil over solid or semiliquid wastes can present special problems. The elastic or plastic characteristics of the wastes can absorb a portion of the energy exerted as compactive effort. This may result in a lift of soil which will not meet density requirement. It has been recommended in several publications that the standard moisture-density test (ASTM D698) be modified to a 5 to 15 blows-per-layer test. Maximum dry density as determined by this test is a more realistic value. It has been recommended that a compaction specification of 90% of maximum dry density, as determined by this modified test method, be used. Since the source for the cover material has not been established, it will be necessary to test the cover material when a source is located to establish the compaction specification.

The placement and compaction of the cover should be sequenced such that work proceeds simultaneously. Once a lift is placed, compaction should follow immediately to prevent loss of moisture. It follows, that material should not be placed during a work day which cannot be compacted the same day. Once the top lift is placed and compacted, the topsoil layer should be spread. The topsoil layer serves as a buffer between the compacted layers and the atmosphere. To provide for establishment of plant growth, the topsoil layer should not be compacted. Seeding should follow placement of the topsoil in a reasonably short time.

5. Topsoil and Vegetation

The purpose of the topsoil layer is to provide a buffer between the atmosphere and compacted cover layers, as well as to provide a growing media for vegetation. The source of topsoil for the cover has not been established. Existing soils at the site are an acceptable source, as well as the utilization of an enhanced topsoil substitute such as the New Providence shale. A discussion of possible topsoil sources and tests to be run to evaluate these sources is presented in a preceding section of this report. For purposes of evaluating topsoils, agronomic considerations should prevail. Enhancement of the topsoil or topsoil substitute should be based on the agricultural testing parameters of soil pH and available plant nutrients.

Vegetation on the cover provides erosion protection and limits the rate of moisture evaporation, thereby reducing infiltration by preventing cracking and breaching of the cover by erosion. To protect the soil cap from erosion and drying, thereby protecting the clay cover, a strong stand of vigorous vegetation will be established. Vegetation reduces raindrop impact on runoff velocity, strengthens the soil mass, and holds moisture to prevent dry cracking.

Over the largest portion of the site, the moderate grades allow for the application of a general seed mixture. This mixture should contain 36% Kentucky 31 Fescue, 22% Perennial Rye, 15% Kentucky Bluegrass, and 27% Annual Rye. The various constituents of the mixture combine to provide a rapid start and strong continued growth. After seeding, the area shall be mulched to protect the seedlings and prohibit erosion.

On the steeper slopes, a seed mixture of 53% Crown Vetch and 47% Perennial Rye shall be applied. This seed mixture has been demonstrated to prosper on steeper slopes and shall be mulched and netted after seeding. The ditches shall be sodded or rip-rapped according to their slopes.

B. DRAINAGE DIVERSION DITCH

To limit the amount of water available for infiltration and erosion within the limit of the cover, a series of diversion ditches is required. These ditches are designed to intercept runoff upland of the site and channel it around the cover area. Ultimately, this surface water is discharged to Wilson Creek just below the site.

An estimate of acreage contributing runoff to the site was made based on a study of the Brooks, Kentucky, topographic quadrangle map published by the United States Geologic Survey and site investigations. The total area of 9.6 acres, which contributes runoff, is steeply sloped and heavily forested. For purposes of runoff calculation, a "C" value of 0.35 was assumed and the time of concentration was taken to be 15 minutes. The intensity associated with this duration, for a 25-year recurrence interval taken from intensity duration curves published by the Kentucky Bureau of Highways, was found to equal 4.9 inches per hour. Application of the rational formula results in a total runoff flow of 16.46 cfs. Natural drainage features upland of the site tend to divide the total flow between the northern and southern ditches. It is estimated that 45% (7.2 cfs) of the flow will be intercepted by the northern ditch and the remaining 55% intercepted by the southern ditch.

For ease of construction, control of erosion, and continued maintainability, a V-ditch section with 4:1 side slopes 2.0 feet deep has been selected. Site geometry dictates a range of slopes from 1.5% to 14% with controlling slope of 3.5% on the northern ditch and 2.5% on the southern ditch. Using the Manning equation (N = 0.090), the depth at design flow can be calculated. The depth of flow in the northern ditch at 7.2 cfs is approximately 1.0 foot, which is acceptable. The depth in the southern ditch at 9.26 cfs is approximately 1.2 feet, which is acceptable. Ditch sections with slopes greater than 10 percent shall be rip rapped.

C. MONITORING WELL SYSTEM

A component of the remedial actions proposed for the A. L. Taylor site is the installation of a monitoring well system. The purpose of this system is to detect any migration of contained contaminants from the site. Available data show that the shallow groundwater system transmits little, if any, water and that the most probable path for any groundwater movement is the weathered shale layer. However, it should be noted that the subsurface conditions existing at the site are virtually impermeable, with permeabili-

ties in the range of 10^{-7} cm/sec. Based upon these conditions, the monitoring wells will be constructed in a manner to secure samples from the weathered shale layer.

It is proposed that the monitoring well system for the A. L. Taylor site consists of a series of seven wells as shown on Figure 7 and detailed in the construction drawings. One well will be located upgradient from the site to monitor background groundwater conditions. The remaining six wells will be located downgradient to monitor for potential pollutant migration. Three of these wells will be located within the site on the down-gradient side of the identified waste cells (refer to Figure 7) to serve as a mechanism for early detection of pollutant migration. The other three wells will be located in a similar arrangement immediately outside the site boundary. The concept behind this approach to the monitoring well system is that if pollutants are detected in the interior wells, then additional remedial actions can be implemented to prevent further pollutant migration. If this occurs, then the three exterior wells will continue to be monitored for the effectiveness of the additional remedial actions, while the interior wells will provide valuable data relative to the extent and degree of pollutant migration.

It is anticipated that the six down-gradient wells will be drilled to a depth of approximately 30 feet, while the up-gradient well will be approximately 100 feet deep. The wells will be constructed in accordance with the specifications and the details provided in the construction drawings.

D. SECURITY FENCE AND SIGNS

A security fence is proposed that will enclose the entire site to prevent unauthorized access by the general public, to protect the installed remedial actions, and to eliminate the potential for human exposure to pollutants. It is proposed that a 6-foot chain-linked fence topped by three strands of barbed wire be installed approximately 15 feet beyond the outside edge of the proposed drainage diversion ditch. This additional space will allow for access around the site, for routine maintenance, and for access to the monitoring wells. The proposed fence will be equipped with two gates, which will be locked at all times, to provide access for authorized personnel and to provide for maintenance of the power line traversing the site. Additionally, it is recommended that several permanent warning signs be placed on the gates and along the fence.

E. RECORD PLAT

Another requirement associated with the closure of the A. L. Taylor site will be to document the location and site history. The following will be required to provide this documentation: survey the site and prepare a record plat that will contain a written warning concerning the waste buried at the site; identify the location of the waste cells; provide a caution relative to future use of the site; and file this information in the public records of Bullitt County.

IV. SUMMARY

This design report for remedial actions at the A. L. Ta te has summarized the available background data, analyzed the site's ge nnical characteristics, documented the applicable design considerations, and detailed the proposed remedial actions. The accompanying set of plans and specifications provides the information necessary for construction of the proposed remedial actions.

The proposed remedial actions for the A. L. Taylor site can be summarized as follows:

- Impermeable Cap and Cover
- Drainage Diversion Ditch
- Monitoring Well System
- Security Fence and Signs
- Record Plat

These proposed remedial actions are predicated on the integrity of the in-place soils and shales and their ability to preclude migration of the buried wastes. Data for the site reveals numerous supportive facts relative to this approach that can be summarized as follows:

- The underlying shale (bedrock) is deep and massive with no detectable fractures and will preclude the vertical migration of existing contaminants.
- The up-gradient groundwater recharge area is minimal and results in virtually no groundwater movement onto the site.
- The native, in-place soils and shales possess permeabilities on the order of 10^{-7} cm/sec and are considered acceptable for providing on-site containment of hazardous wastes.

Additionally, the site will be provided with six down-gradient monitoring wells. Three of these wells will be located within the site on the down-gradient side of the identified waste cells to serve as a mechanism for early detection of pollutant migration. The other three wells will be located in a similar arrangement immediately outside the site boundary. The concept behind this approach to the monitoring well system is that if pollutants are detected in the interior wells, then additional remedial actions can be implemented to prevent further pollutant migration. If this occurs, then the three exterior wells will continue to be monitored for the effectiveness of the additional remedial actions, while the interior wells will provide valuable data relative to the extent and degree of pollutant migration.

APPENDIX 1

GEOLOGICAL SITE INVENTORY

SUBSURFACE SAMPLE DESCRIPTION

TAKEN FROM E AND E REPORT,

"REMEDIAL ACTION SITE INVESTIGATION,"

DATED DECEMBER, 1982

APPENDIX 2

BACKGROUND DATA AND

WATER BALANCE CALCULATIONS

Climatological Data

For purposes of water balance calculations, precipitation and temperature data [illegible] taken from the 1979 Local Summary for Hartford published by the National Climatic Data Center [illegible] monthly rainfall and average temperatures along with the departures from normal. The normal monthly [illegible] were determined. Data [illegible] the WFSO weather station were used.

Precipitation

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Average annual precipitation = [illegible] " = [illegible] mm

Temperature

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Potential Evapotranspiration

Using Calculation [illegible] method for calculating potential evapotranspiration (From Chow, [illegible], ed., Handbook of Applied Hydrology, New York, McGraw-Hill, [illegible]):

$$PET = PET_{[illegible]} \frac{L}{360} \text{ mm/month}$$

$$PET_{[illegible]} = \left(\frac{[illegible]}{J}\right)^{a} \text{ mm/month}$$

Month	Temp (°F)	(°C)	$i = \left(\frac{T}{5}\right)^{1.5}$	$PET = \left(\frac{[illegible]}{J}\right)^{a}$
[illegible]	22.5	0.7	0.03	0.60
[illegible]	[illegible]	[illegible]	0.27	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	13.[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	19.[illegible]	7.07	[illegible]
[illegible]	[illegible]	22.9	10.01	[illegible]
[illegible]	[illegible]	24.[illegible]	11.37	[illegible]
[illegible]	[illegible]	24.4	11.02	[illegible]
[illegible]	[illegible]	20.[illegible]	8.53	93.27
[illegible]	[illegible]	14.[illegible]	[illegible]	55.97
[illegible]	45.0	[illegible]	1.74	20.23
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
			$\Sigma i = [illegible]$	

[illegible]

[illegible]

	[illegible]	[illegible]	[illegible]	PET
[illegible]	0.[illegible]	3.	.52	0.00
FCL	3.37	25	[illegible]	2.64
[illegible]	[illegible]	3	1.[illegible]	[illegible].39
[illegible]	45.37	[illegible]	[illegible]	54.21
[illegible]	[illegible]	[illegible]	[illegible]	99.00
[illegible]	[illegible]	[illegible]	[illegible]	134.50
[illegible]	[illegible]	[illegible]	[illegible]	159.96
[illegible]	[illegible]	[illegible]	[illegible]	174.23
[illegible]	[illegible]	[illegible]	[illegible]	97.00
[illegible]	[illegible]	[illegible]	[illegible]	55.52
[illegible]	[illegible]	[illegible]	[illegible]	6.[illegible]
[illegible]			[illegible]	[illegible]
				7[illegible].21 = ΣPET

Runoff Coefficient

Factors to base choice of coefficients

1. Sandy loam, clay loam or clay type soils
2. Slopes in the range of 7% or greater

For Estimation EPA 600/SW-168	Table 3	0.25 - 0.35
Ky DOT Drainage Manual	Figure 2-501	0.24
Hydrology Handbook	Table 2.27	0.42 - 0.60

For Purposes of Water Balance Calculations Runoff Coefficients of 0.24 for dry seasons and 0.35 for wet seasons will be used

Soil Moisture Storage

Information on soil moisture storage and moisture retention is taken from the following publication:

Fenn, D.G., et al., 'Use Of The Water Balance Method For Predicting Leachate Generation From Solid Waste Disposal Sites', EPA 1530/SW-168, October 1975

Soil moisture storage for A.L. Taylor site based on soils at the site being silt loams, clay loams and clayey. Value from Table 2 in the above referenced publication for clay loam is 375 mm per meter of soil depth.

Soil moisture storage for conditions analyzed:

Freshwater Layer (30" x 2.54 cm/in ÷ 100) x 375 = 343 mm

Existing Conditions (12" x 2.54 ÷ 100) x 375 = 114 mm

Remedial Action (30" x 2.54 ÷ 100) x 375 = 295 mm

Soil moisture retention for those months where an accumulated potential water loss exists was assumed based on interpretations from data in the above referenced publications.

Water Balance Calculation

A. L. Taylor Site - Cobalt Cooling Pre-Waste Disposal

Parameter	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	
PET	0.6	2.6	19.4	54.3	99.0	134.9	150.9	127.9	97.0	55.5	17.0	2.7	[illegible]	
Precipitation P	89.7	88.1	122.3	104.1	106.7	102.9	75.6	75.9	74.7	59.7	84.6	84.8	1035.0	*
Runoff Coef. C_{RO}	0.35	0.35	0.35	0.35	0.35	0.24	0.24	0.24	0.24	0.24	0.24	0.35	-	
Runoff $P \times C_{RO}$	31.4	30.8	44.9	36.4	37.4	24.7	22.9	18.2	17.9	14.3	20.3	29.7	326.1	*
Infiltration P - RO	58.3	57.3	83.4	67.7	69.3	78.2	52.6	57.7	56.8	45.4	64.3	55.1	-	
I - PET	57.7	54.7	64.0	13.4	-29.7	-56.7	-97.4	-86.5	-40.2	-10.1	47.3	52.4	-	
Σ Neg (I-PET)				0	-29.7	-86.4	-183.8	-270.3	-310.5	-310.6			-	
Soil Moist. ST	229.2	283.9	343	343	313.3	256.6	169.2	99.0	77.6	71.8	119.1	171.5	-	
Change ΔST	+57.7	+54.7	+59.1	0	-29.7	-56.7	-87.4	-70.2	-21.4	-5.8	+47.3	+52.4	-	
Actual ET	0.6	2.6	19.4	54.3	99.0	134.9	150.9	127.9	78.2	51.2	17.0	2.7	777.3	*
Percolation	0	0	4.9	13.4	0	0	0	0	0	0	0	0	18.3	*

Water Balance Calculation

A.L. Taylor Site, Bullitt County, Existing Conditions

Parameter		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	
PET		0.6	2.6	19.4	54.3	99.0	134.9	160.0	144.2	97.0	55.5	17.0	2.7	787.2	
Precipitation	P	89.7	88.1	128.3	104.1	106.7	102.9	95.5	75.9	74.7	59.7	84.6	84.8	1095.0	*
Runoff Coef.	CRO	0.28	0.28	0.28	0.29	0.28	0.29	0.28	0.28	0.28	0.28	0.28	0.28	-	
Runoff	P x CRO	25.1	24.7	35.9	29.1	29.9	28.8	26.7	21.3	20.9	16.7	23.7	23.7	306.5	*
Infiltration	I = P - PRO	64.6	63.4	92.4	75.0	76.8	74.1	68.8	54.6	53.8	43.0	60.9	61.1	-	
I - PET		64.0	60.8	73.0	20.7	-22.2	-60.8	-91.2	-87.6	-43.2	-12.5	43.9	58.4	+ 1.3	
Σ Neg (I - PET)					0	-22	-83	-174	-263	-307	-320			-	
Soil Moisture	ST	114	114	114	114	93	54	24	11	7	6	49.9	108.3	-	
Change	ΔST	+5.7	0	0	0	-21	-39	-30	-13	-4	-1	+43.9	+58.4	-	
Actual ET		0.6	2.6	19.4	54.3	97.8	113.1	98.8	67.6	57.8	44.0	17.0	2.7	575.7	*
Percolation		58.3	60.8	73.0	20.7	0	0	0	0	0	0	0	0	212.8	*

Water Balance Calculation

A. L. Taylor Site, Bullitt County, Remedial Action

Parameter		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	
PET		0.6	2.6	19.4	54.3	99.0	134.9	160.0	144.2	97.0	55.5	17.0	2.7	787.2	
Precipitation	P	89.7	88.1	128.3	104.1	106.7	102.9	95.5	75.9	74.7	59.7	84.6	84.8	1095.0	*
Runoff Coef.	C/O	0.35	0.35	0.35	0.35	0.35	0.24	0.24	0.24	0.24	0.24	0.24	0.35	-	
Runoff	P x C/O	31.4	30.8	44.9	36.4	37.4	24.7	22.9	18.2	17.9	14.3	20.3	29.7	328.9	*
Infiltration	P - R/O	58.3	57.3	83.4	67.7	69.3	78.2	72.6	57.7	56.8	45.4	64.3	55.1	-	
I - PET		57.7	54.7	64.0	13.4	-29.7	-56.7	-87.4	-86.5	-40.2	-10.1	47.3	52.4	-	
Σ Neg (I-PET)					0	-29.7	-86.4	-173.8	-260.3	-300.5	-310.6			-	
Soil Moist.	ST	213.4	268.1	285	285	255.3	198.6	124	77	60	56	103.3	155.7	-	
Change	ΔST	+57.7	+54.7	+16.9	0	-29.7	-56.7	-74.6	-47	-17	-4	+47.3	+52.4	-	
Actual	ET	0.6	2.6	19.4	54.3	99.0	[illegible]	[illegible]	104.7	73.8	49.4	17.0	2.7	-	
Percolation		0	0	47.1	13.4	0	0	0	0	0	0	0	0	60.5	*

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LIST OF PROJECTS

GEOSCIENCES RESEARCH ASSOCIATES, INC.

Year	Cost or Bid Estimate	Client	Project Description
79-80	143,301	Purdue U./EPA Grant	Groundwater inventory for Indiana for EPA underground injection control program
80	1,290	Wayne Hamilton, Danville, IL	Log oil well and geophysical interpretations
80	1,677	NEWCO, Indianapolis, IN	Groundwater study for development of coal mine
80	240	Don Darnell, Newport, IN	Groundwater study to determine extent of contamination from nitrate spill
80	1,327	Smith, Hinchman & Grylls, Detroit, MI	Determine groundwater flow characteristics in karst area
80	2,707	Soil Systems, Inc., Bloomington, IN	Lithic materials and geomorphology study of archaeological site
80	286	Ind. Cal Pro, Nashville, TN	Limestone fracture analysis for underground mine
80	1,458	Orbit Gas Co., Owensboro, KY	Air photo analysis of fractures
80	45,203	U.S. OSM, Indianapolis, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
80	2,012	Resource Analysts, Bloomington, IN	Geomorphology and soils study for archaeological site
80	200	Tom Davis, Zion, IL	Property evaluation for coal reserves
81	2,220	U.S. DOI/HCRS, Ann Arbor, MI	National natural landmarks study for several sites in Indiana
81	1,345	Halderman Farms, Wabash, IN	Property evaluation for coal reserves
81	3,160	John Kyle, Noblesville, IN	Expert witness for litigation, environmental study of affects of new highway
81	304	Eng. & Test. Service, Indianapolis, IN	Consultation regarding groundwater hydrology and geomorphology in a karst area

Year	Cost or Bid Estimate	Client	Project Description
81	1,055	Warren Energy Corp., Owensboro, KY	Fracture and lineament analysis from air photos and LANDSAT
81	1,786	Richalyn Indus., Owensboro, KY	Fracture and lineament analysis from air photos and LANDSAT
81	409	Judy Van Ablee, Indianapolis, IN	Property evaluation for coal reserves
81	160	Henry Ruppert, Bloomington, IN	Consultation regarding soils and geomorphology for property development
81	3,400	George Craig, Brazil, IN	Expert witness for litigation, blast damage
81	160	Robert Howard, Louisville, KY	Consultation regarding springs in Indiana
81	33,008	U.S. OSM/CDM subcontract	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
81	4,748	U.S. OSM/SIECO subcontract	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
81	7,082	County Line Stone, Scotland, IN	Surface and groundwater hydrology and geology study limestone quarry
81	468	City of Dana, IN	Groundwater study for city wells
81	3,502	Larry Baker, Bloomington, IN	Surface water and groundwater hydrology evaluation and geomorphology interpretation of karst area for development
81	690	George Jerutis, New Lenox, IL	Property evaluation for oil reserves
81-82	2,100	Don Campbell, Convington, IN	Expert witness for litigation, blast damage
81-82	39,442	U.S. OSM, Indianapolis, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
81-82	80,340	U.S. OSM, Indianapolis, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
82	1,000	Comet Coal & Clay Co., Linton, IN	Surface water hydrology study and sediment pond design

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Year	Cost or .d Estimate	Client	Project Description
82	5,540	U.S. DOI Nat. Park Service, Atlanta, GA	National natural landmarks study in AL, TN, and
82	1,305	U.S. DOI Nat. Park Service, Atlanta, GA	National natural landmark study in GA
62	7,250	U.S. OSM/SIECO subcontract	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
82	16,414	U.S. OSM/SIECO subcontract	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
82	15,000	Central Disposal, Inc., Switz City, IN	Surface water and groundwater hydrology and geology evaluation for sanitary landfill
82	505	Wernigk Coal, Clinton, IN	Coal mine permit application
82	2,842	Foertsch Const., Lamar, IN	Surface water hydrology assessment for coal mine
82	1,105	Gene Glicks Co., Indianapolis, IN	Geology study for construction materials
82	213	Delta Mining, Tell City, IN	Soils study for dam construction
82	1,224	County Line Stone, Scotland, IN	Rock analyses for limestone quarry
82	800	Mulzer Crushed Stone, Tell City, IN	Evaluation of quality and quantity of gravel deposit
82-83	193,000	Purdue U./EPA Grant	Groundwater quality and quantity study for Indiana (EPA, UIC program)
82-83	36,000	U.S. DOI, Nat. Park Serv., Atlanta, GA	Geomorphology and geology evaluation of East Gulf Coastal Plains for Nat. natural landmarks
82-83	3,500	Resource Analysts, Bloomington, IN	Geomorphology study along Ohio River for archaeological site
82-83	9,000	BFC Coal Co., Boonville, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
82-83	2,000	Central Disposal, Inc., Switz City, IN	Groundwater quality study for sanitary landfill
82-83	16,000	Coal, Inc., Linton, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining. Prepare permit application for coal mine
82-83	10,000	Comet Coal & Clay, Linton, IN	Prepare two coal mine permit applications

Year	Cost or Bid Estimate	Client	Project Description
82-83	1,200	Dyer Construction, Huntington, IN	Surface water and groundwater hydrology and geo baseline study for predicting affects of strip mining
82-83	9,000	Fossil Fuels, Bloomfield, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining, and preblast surveys
82-83	8,000	General Motors, Bedford, IN	Surface water and groundwater hydrology evaluation for a surface impoundment
82-83	7,000	Great Lakes Limited, Terre Haute, IN	Surface water and groundwater hydrology study to predict affects of surface mining
82-83	4,500	Green Ridge Coal, Tell City, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects on strip mining
82-83	4,000	Haviland Coal, Coal City, IN	Prepare coal mine permit application
82-83	1,000	ATEC Assoc., Indianapolis, IN	Ecology study to predict affects of surface mining
82-83	3,000	Invesco International, Odon, IN	Surface water and groundwater hydrology study to predict affects of surface mining
82-83	10,000	J H & L Coal Co., Terre Haute, IN	Prepare coal mine permit application
82-83	25,899	Ind. DNR, Div. Rec., Indianapolis, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
82-83	1,500	J & J Coal Co., Boonville, IN	Assist in preparing coal mine permit application
82-83	3,653	SIECO, Inc., Columbus, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining
82-83	25,000	Life Systems, Inc., Cleveland, OH	Surface water and groundwater hydrology and geomorphology study in karst area
82-83	20,000	Marigold Mining, Lamar, IN	Prepare three coal mine permit applications
82-83	11,554	U.S. DOI Nat. Park Serv., Washington, D.C.	Ecology study of Mississippi Embayment for Nat. natural landmarks
82-83	5,000	S & G Excavating, Terre Haute, IN	Surface water and groundwater hydrology and geology baseline study for predicting affects of strip mining

Year	Cost or Bid Estimate	Client	Project Description
82-83	9,000	Superior Coal, Jasper, IN	Surface water and groundwater hydrology and ge baseline study for predicting affects of strip mining
82-83	2,500	Vigo Coal Co., Inglefield, IN	Surface water hydrology and geology study to predic affects of coal mining
82-83	3,000	Wabash Valley Coal, Terre Haute, IN	Surface water hydrology and geology study to predict affects of coal mining
83	12,000	Life Systems, Inc., Cleveland, OH	Surface water and groundwater hydrology and geomorphology study in karst area
83	1,200	Smith Quillman Assoc., Bloomington, IN	EIS for Water's Edge Condominium, The Pointe, Lake Monroe, Monroe County, IN
83	2,500	Alternative Designs, Inc., Brownstown, IN	Categorical Exclusion for bridge in Jackson County, IN
83	6,000	Alternative Designs, Inc., Brownstown, IN	Environmental Assessment for bridge in Jackson County, IN
3	1,500	Smith Quillman Assoc., Bloomington, IN	Geotechnical support and design of drainage treatment for sinkholes.
83	5,000	National Laboratory, Evansville, IN	Geologic and Hydrologic analysis of proposed surface coal mine.
83	13,000	Woolpert Consultants, Dayton, OH	Geologic and hydrologic studies for abandoned underground mine closure in Sullivan Co., IN.
33	40,000	Purdue U./US EPA Grant	Oil well brine sampling and analysis for groundwater studies in Indiana.

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RECORD OF DECISION

REMEDIAL ALTERNATIVE SELECTION
6-18-86

Site: A. L. Taylor Site (Valley of the Drums), Bullitt County, Kentucky

Documents Reviewed

I am basing my decision primarily on the following documents describing the analysis of cost and effectiveness of remedial alternatives for the A. L. Taylor Site.

Conestoga-Rovers and Associates Limited, 1986 Preliminary Remedial Construction Design, A.L. Taylor Site, Bullitt County, Kentucky.

Metcalf and Eddy, Inc., 1984, Feasibility Study Addendum and Endangerment Assessment of the A. L. Taylor Site, Brooks, Kentucky.

Geosciences Research Associates, Inc., 1984, Hydrologic Investigation of the A. L. Taylor Site, Bullitt County, Kentucky.

Geosciences Research Associates, Inc., 1983, Technical Proposal for Soil and Groundwater Testing and Permeability Determination at A. L. Taylor Landfill Site, Bullitt County, Kentucky.

NUS Corporation, 1983, Sampling Investigation Report, A. L. Taylor Site, Brooks, Kentucky.

Metcalf and Eddy, Inc., 1983, Review of Data and Proposed Remedial Alternative for one A. L. Taylor Site, Brooks, Kentucky.

Geosciences Research Associates, Inc., 1983, A. L. Taylor Site Onsite Containment Plan.

Tenech Environmental Engineers, Inc., 1983, Final Design Report for Remedial Action of the A. L. Taylor Hazardous Waste Disposal Site.

Ecology and Environment, Inc., 1982, Feasibility Study of Remedial Alternatives for the A. L. Taylor Site, Task Report to the EPA.

Ecology and Environment, Inc., 1982, Remedial Action Site Investigation, A. L. Taylor Site, Brooks, Kentucky. Task Report to the EPA.

U.S. EPA, 1982, Historical Analysis A. L. Taylor Site, Brooks, Kentucky. Environmental Monitoring System Laboratory Environmental Photographic Interpretation Center, Warrenton, Virginia.

Ecology and Environment, Inc., 1982, A. L. Taylor Site Deep Test Boring, Letter Report.

Ecology and Environment, Inc., 1981, Geologic Investigation at A. L. Taylor Site, Letter Report to Richard D. Stonebraker.

Technos, Inc., 1981, Subsurface Investigation of the A. L. Taylor Hazardous Material Site, Bullitt County, Kentucky, Report to Ecology and Environmental Inc. and U.S. EPA.

Tenech Environmental Engineers, Inc., 1983, Contract Documents for Remedial Actions at the A. L. Taylor Hazardous Waste Disposal Site.

Tenech Environmental Engineers, Inc., 1983, Remedial Actions for the A. L. Taylor Hazardous Waste Disposal Site.

U.S. EPA, 1980, Valley of the Drums, Bullitt County, Kentucky, Oil and Special Materials Control Division, Washington, D.C.

U.S. EPA, 1979, Valley of the Drums, Shepherdsville, Kentucky, Environmental Response Team, Edison, New Jersey.

U.S. EPA, 1979, Soil Coring Study, A. L. Taylor Hazardous Waste Site, Bullitt County, Kentucky, Region IV Surveillance and Analysis Division, Athens, Georgia.

U.S. EPA, 1979, Environmental Monitoring Activities Associated with Hazardous Waste Storage Sites, Louisville, Kentucky, Region IV Surveillance and Analysis Division, Athens, Georgia.

U.S.G.S., 1960, Availability of Groundwater in Bullitt, Jefferson and Oldhall Counties, Kentucky.

Staff Summaries and Recommendations are atttached.

Description of Selected Remedy

The selected remedy includes:

- Remove surface water from the site.
- Secure pond sediments, sludge and materials from low-lying areas beneath the cap.
- Install final cap cover for containment of the waste materials.
- Construct a surface water drainage diversion which will route surface water around the cap area and which can accommodate a 25 year/24 hour storm.
- Implement a performance monitoring program on Wilson Creek (the only potential receptor of chemical migration) to evaluate the effectiveness of the clay cap insuring mitigation of surface chemical migration.
- Following the completion of the remedial construction the site will be secured with the installation of a six foot high chain link fence with appropriate gates.
- The site will be subject to a regular inspection and maintenance program following completion of remedial construction for a period of thirty (30) years.
- The active contaminant migration pathway at the A. L. Taylor site is by surface water runoff. The final cover is proposed as a method of containing waste materials and preventing contact between surface water and waste.
- Based on the cost-effective criteria of Section 300.68 (j) of the National Contingency Plan, evaluation of the remedial alternatives and the endangerment assessment, EPA recommends that the onsite contaminment alternative as proposed in the conceptual design submitted by the potentially responsible parties be implemented at this site.

DECLARATIONS

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and the National Contingency Plan (40 CFR Part 300), I have determined that the on site containment alternative is a cost effective remedy and provides adequate protection of public health, welfare and the environment. The Commonwealth of Kentucky has been consulted and agrees with the approved remedy.

In addition, the action will require future O & M activities to ensure the continued effectiveness of the remedy. These activities will be considered part of the approved actions and eligible for Trust Fund monies for a period not to exceed 1 year.

I have also determined that the action being taken is appropriate when balanced against the availability of Trust Fund monies for use at other sites.

JUN 18 1986

Date

Jack E. Ravan
Regional Administrator

Record of Decision
Remedial Alternative Selection
A. L. Taylor Site
Brooks, Kentucky

SITE LOCATION AND DESCRIPTION

The A. L. Taylor site, also known as "Valley of the Drums", is an uncontrolled industrial waste dump located in a small valley in northern Bullitt County just south of the Jefferson County line off Kentucky State Highway 1020 outside the community of Brooks, Kentucky (see figure 1).

The topography of the north-central portion of Bullitt County is characterized by steep slopes, particularly in that portion of the county bordering Jefferson County. The A. L. Taylor site falls within this general characterization having 20 to 30 percent slopes on the western and northern sides of the site and 10 percent on the southern and eastern sides. The site is not within any 100 year flood plain. Most of the surface area of the site has been graded so that the land gradually slopes eastward toward Wilson Creek, located adjacent to the site. There are five residences and a private country club located within a few thousand feet of the site.

Groundwater at the site occurs in two aquifers: a shallow unconfined perched aquifer and a deeper confined limestone aquifer. Groundwater monitoring wells drilled on site in both water-bearing units show that both are unusable as drinking water supplies due to poor quality and low yield. Local populations around the site use cisterns and public water supplies.

Wilson Creek, located adjacent to the site, is a small stream subject to seasonal low flow conditions. The stream lies within the Salt River drainage basin and is classified for recreational use.

SITE HISTORY

The A.L. Taylor site was first identifed as a waste disposal site by the Kentucky Department of Natural Resources and Environmental Protection (KDNREP) in 1967. The actual disposal site covers 13 acres of the 23-acre tract owned by Mr. Taylor. The surface features of the site have been substantially disturbed. Mr. Taylor excavated pits on site and emptied the contents of the drums into them and recycled the drums. Soil from nearby hillsides was eventually used to cover the pits after the KDNREP stopped Mr. Taylor from burning solvents. Thousands of drums were also stored on the surface, especially during later years of operations. During the remedial investigation, four or five major cells of buried wastes containing chemical liquids, sludges and crushed drums were identified.

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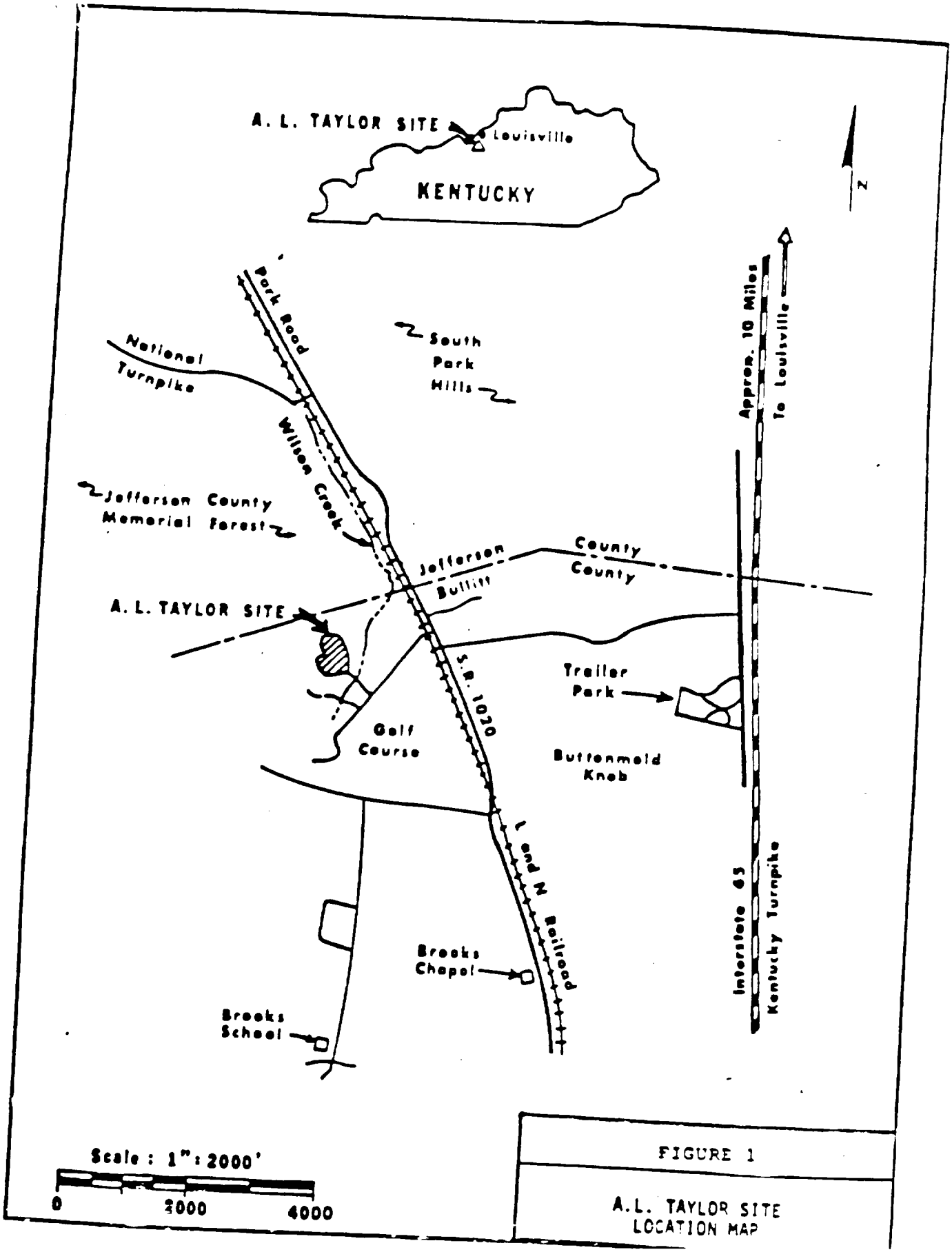

FIGURE 1

A.L. TAYLOR SITE LOCATION MAP

Throughout the history of site operations from 1967 to 1977 Mr. Taylor never applied for the required state permits. The KDNREP first documented releases of hazardous substances from the site in 1975. They pursued legal actions against Mr. Taylor until his death in late 1977.

In January 1979, at the request of the KDNREP EPA responded to releases of oil and hazardous substances at the A. L. Taylor site. Under the authority of Section 311 of the Clean Water Act, the EPA Emergency Response Branch On-Scene Coordinator prevented further releases of pollutants into nearby Wilson Creek by constructing interceptor trenches and a temporary water treatment system, securing leaking drums, and segregating and organizing drums on site.

In 1980 the KDNREP contacted six responsible parties who identified and removed approximately 30 percent of the waste remaining on the surface of the site. Following this removal an estimated 4,200 drums remained.

In 1981 EPA again inspected the site and discovered deteriorating and leaking drums and discharges of pollutants into Wilson Creek occurring once again. EPA, responding under the emergency provisions of CERCLA, upgraded the existing treatment system and removed the remaining 4,200 drums of surface wastes off site for recycling or disposal. There remains, however, an unknown amount of waste buried on site.

CURRENT SITE STATUS

The paints and coatings industries of the Louisville area were the primary waste generators using the A. L. Taylor site. Some of the drums were emptied into open pits, cleaned and recycled. Other drums were buried on site, and during the later years of operation many drums were stored on the surface. The open pits which were once used for burning solvents had been covered over prior to EPA's involvement.

The initial drum inventory conducted in 1979 showed 17,051 drums on the surface and of those, 11,628 were empty. During the 1979 emergency response, several disposal pits were discovered. Over the next three years several investigations were conducted to define those disposal pits, including exploratory test pits and the use of geophysics (see Figure 2). An estimated volume of material and number of drums in each disposal pit is given in Figure 3.

Analytical data has been collected during several site actions including the two immediate removals and the remedial investigation. Hazardous substances detected on site include the following classes of compounds: heavy metals, ketones, phthalates, polychlorinated biphenyls (PCB), chlorinated alkanes and alkenes, aromatics, chlorinated aromatics, and polynuclear aromatics. In all,

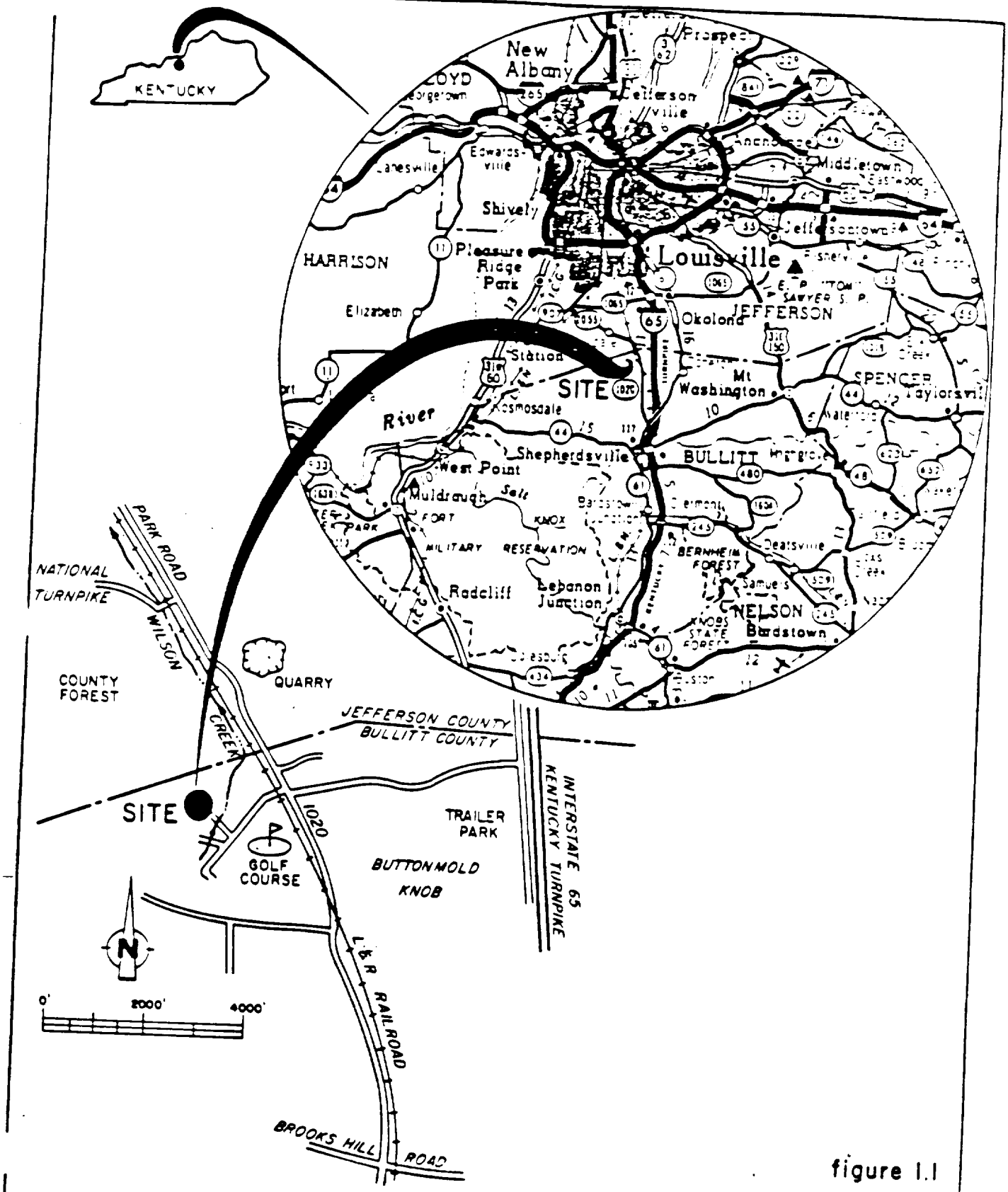

figure 1.1
SITE LOCATION
A.L. TAYLOR SITE
Bullitt County, Kentucky

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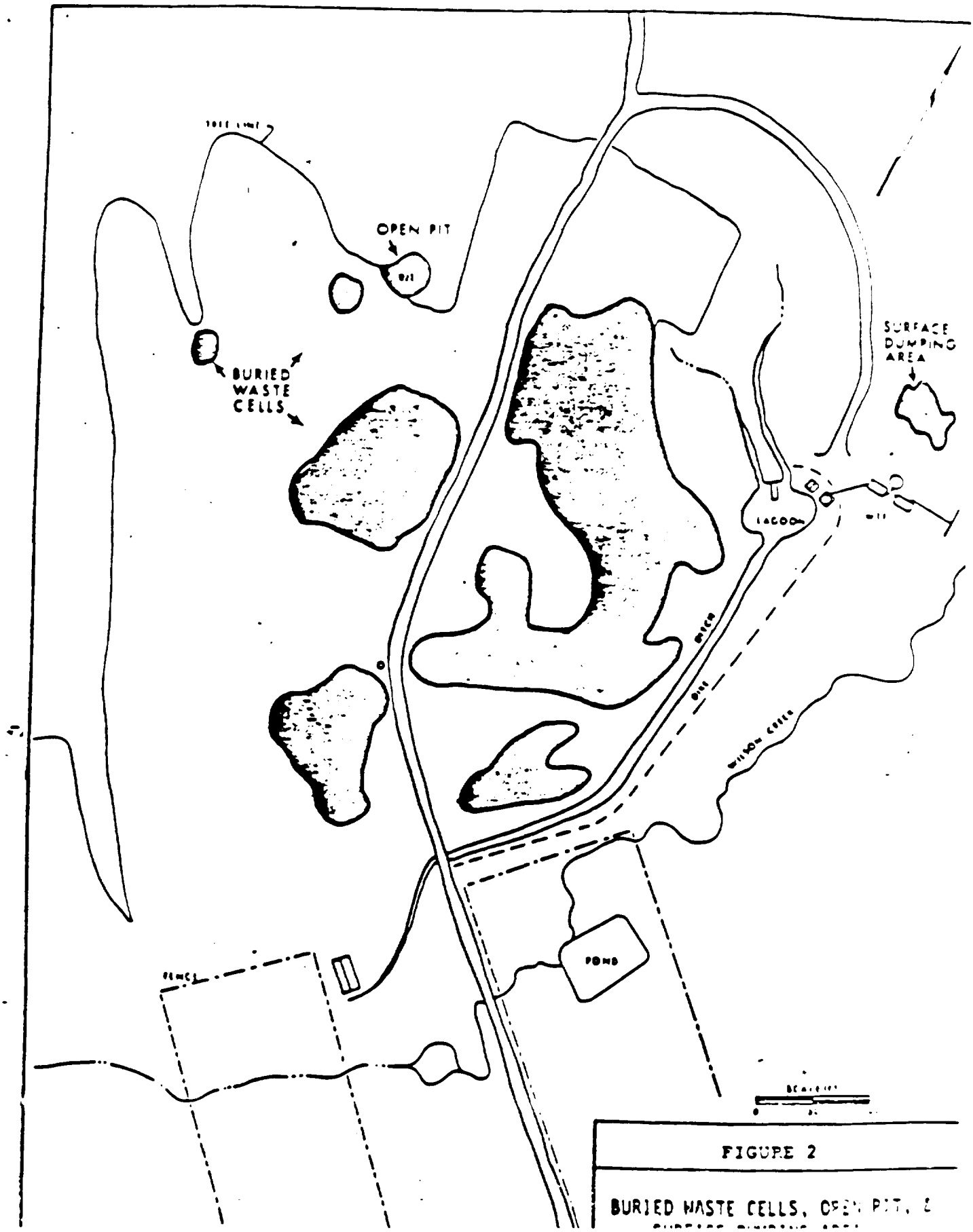

FIGURE 2

BURIED WASTE CELLS, OPEN PIT, &

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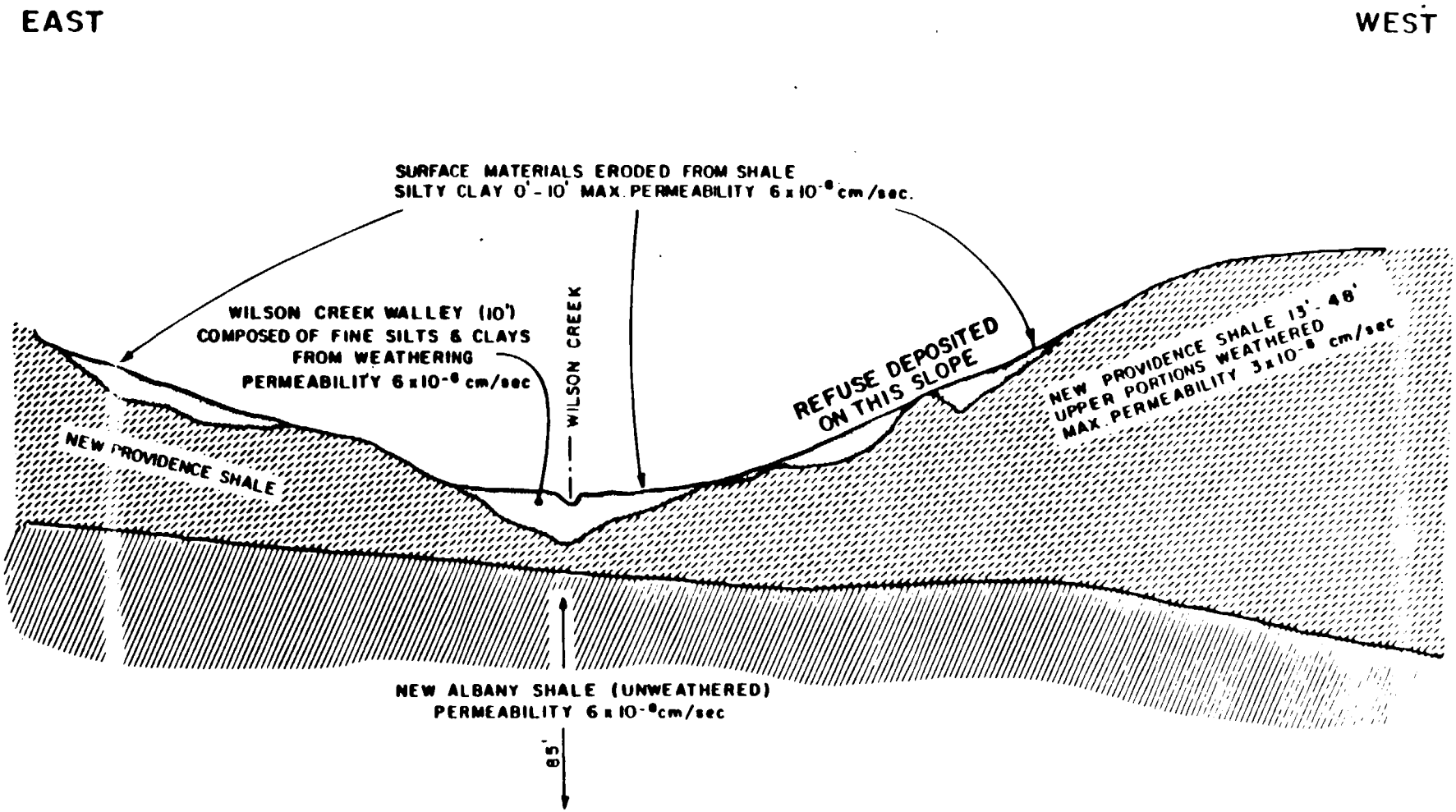
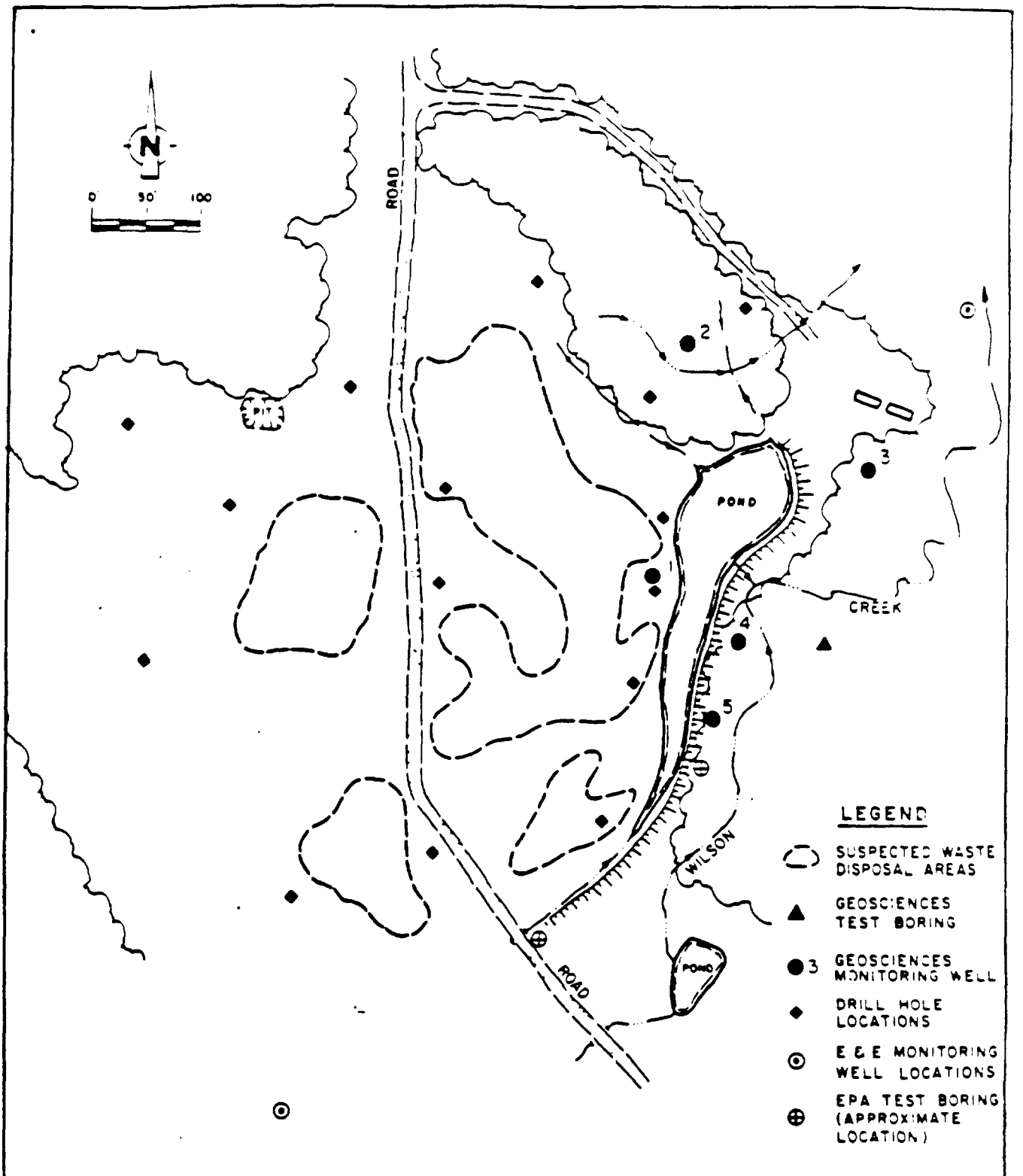


figure 2.1

SCHEMATIC OF
ORIGINAL VALLEY AND CURRENT GEOLOGY
Bullitt County, Kentucky

CRA



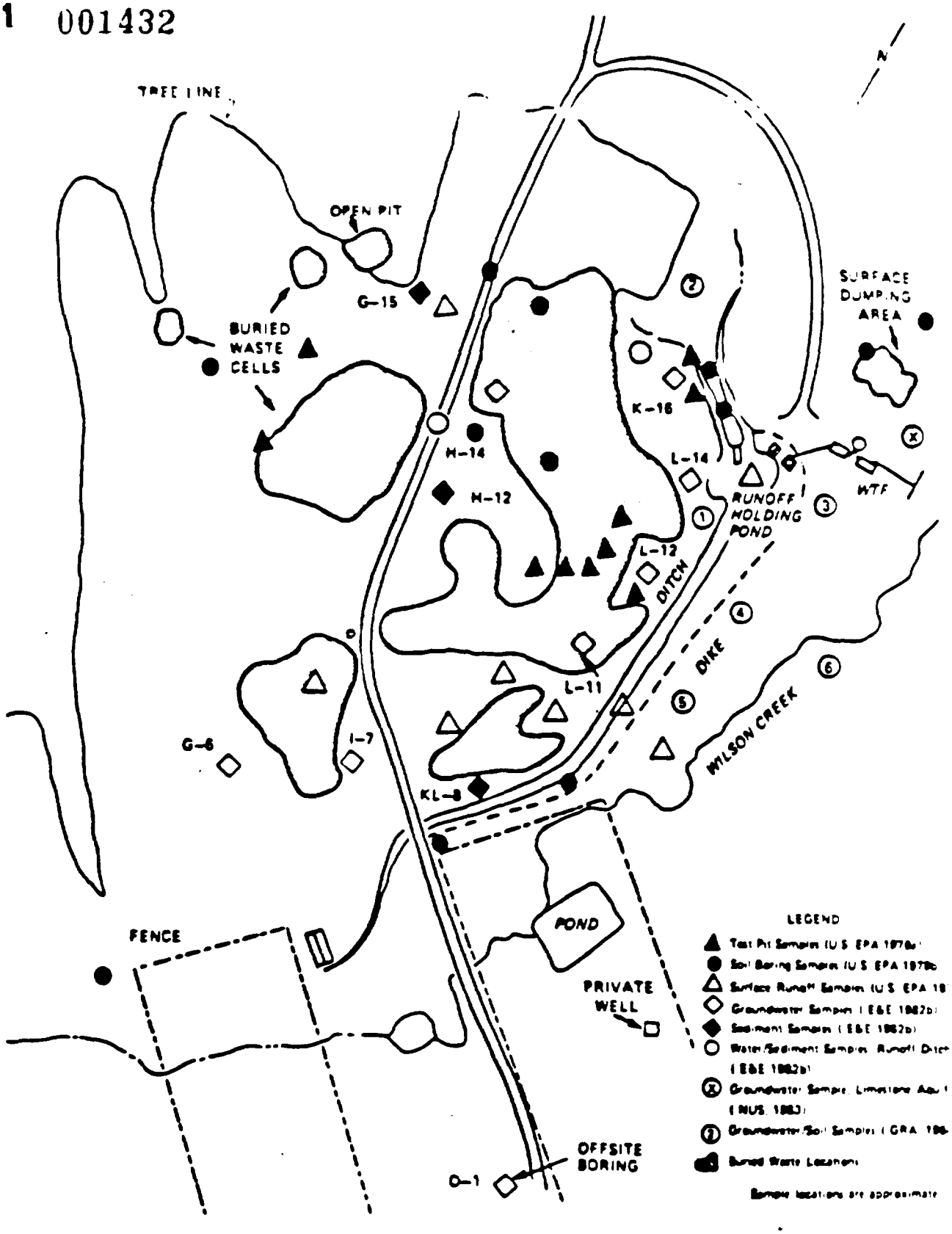
NOTE REFERENCE TAKEN FROM FIGURE 1 - MAP OF TAYLOR SITE SHOWING LOCATIONS OF TEST BORINGS AND MONITORING WELLS

MAP MODIFIED FROM TENECH, SEPTEMBER 1983, FINAL DESIGN REPORT

figure 2.3

EXISTING TEST BORING AND MONITORING WELL LOCATIONS
A.L. TAYLOR SITE
Bullitt County, Kentucky

CRA



SAMPLING LOCATIONS AND SUSPECTED WASTE DISPOSAL AREAS (SHADED AREAS)

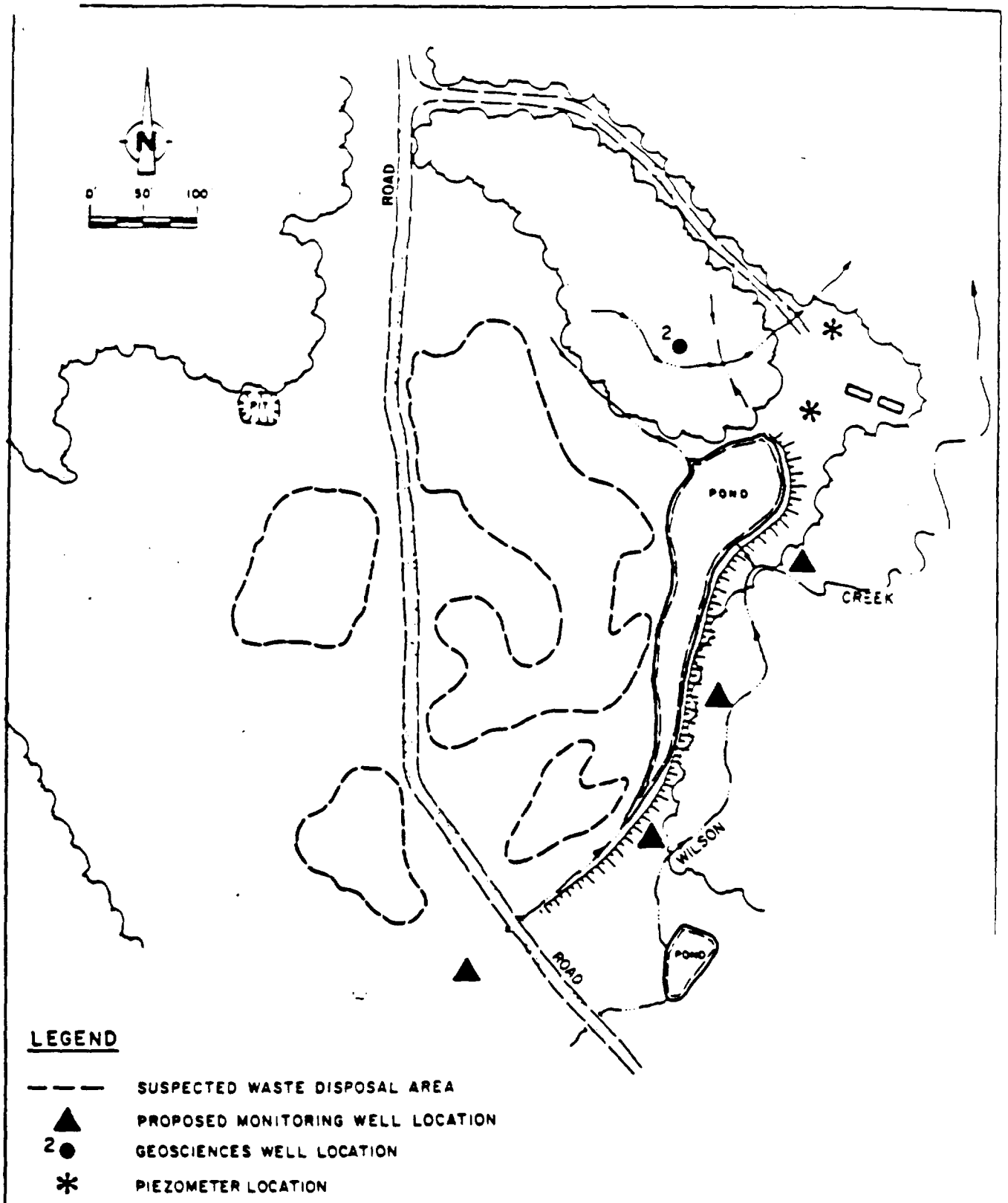


figure 3.2

PROPOSED MONITORING WELL LOCATIONS
A.L. TAYLOR SITE
Bullitt County, Kentucky

CRA

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FIGURE 3

ESTIMATED QUANTITY OF BURIED WASTES
AT THE A. L. TAYLOR SITE
BROOKS, KENTUCKY

LOCATION	VOLUME OF MATERIAL (in cubic feet) Minimum[1]	Maximum[2]	NUMBER OF DRUMS (uncrushed) Minimum[3]	Maximum[4,5]
Trench 1	78,875	147,125	2155	8040
Trench 2	40,875	66,625	1117	3641
Trench 3	13,750	25,500	376	1393
Trench 4	38,000	63,750	1038	3484
Trench 5	21,812	36,312	596	1984
Totals	193,312	339,312	5282	18,542

NOTES:

1. Calculated using major anomaly area times 5 feet thickness plus significant anomaly area times 2 feet thickness.

2. Calculated using major anomaly area times 10 feet thickness plus significant anomaly area times 2 feet thickness.

3. Calculated using density of one drum per 36.6 cubic feet and minimum volume.

4. Calculated using density of one drum per 18.3 cubic feet and maximum volume.

5. If drums are crushed, the estimated number may increase from two to five times the number of drums given.

6. The values given are order of magnitude estimates only. Area locations are indicated in Figure 1-2. One 55-gallon drum occupies about 9.15 cubic feet. Estimates calculated assume that the drums were randomly dumped, yielding densities ranging from 18.3 to 36.6 cubic feet/drum.

approximately 140 compounds have been identified. The chemicals found most often and in highest concentrations were:

xylene	methyl ethyl ketone
methylene chloride	acetone
phthalates	anthracene
toluene	fluoranthene
alkyl benzene	vinyl chloride
dichloroethylene	aliphatic acids

PCBs were detected in low concentrations and several metals including barium, zinc, copper, strontium, magnesium and chromium were detected in concentrations exceeding background levels.

The highest concentrations of organic contaminants detected on site, other than from drum samples, were from liquid samples collected in the test pits. The average concentration of the major organic compounds detected are found in the first column of Table 2. Some of the same compounds were detected in water samples from borings located downgradient of the test pits and are included in Table 2. It is significant to note that some water samples from the borings were collected immediately downgradient of the disposal cells, yet the analyses showed relatively low concentrations of contaminants when compared to the pit samples.

Groundwater and surface water resources were evaluated as potential routes of exposure to hazardous substances released from the A. L. Taylor site. Under existing and projected usage patterns neither of the sources appears to be a likely route of exposure to populations located downstream of surface water routes or downgradient of groundwater movement from the site.

Groundwater is not currently a source of drinking water in the vicinity of the site. The five homes located closest to the site are on cisterns, other nearby residences and businesses are either on cisterns or are connected to municipal water supplies. Poor water quality and low yield account for the low use of both shallow and deep aquifers near the site. An adjacent landowner had a well drilled but it was never used because of low yield. This well was sampled during the remedial investigation and found to contain concentrations of iron and manganese that were approximately 30 and 3 times National Drinking Water Standards, respectively.

Similarly, a deep well installed in the limestone aquifer during the remedial investigations had a flow rate of four gallons per minute and contained concentrations of chloride that exceeded National Drinking Water Standards by a factor of five.

Another factor limiting future human exposure risks is the limited population growth projected in the vicinity of the site. Topographic features of the area surrounding the site make it largely unsuitable for development.

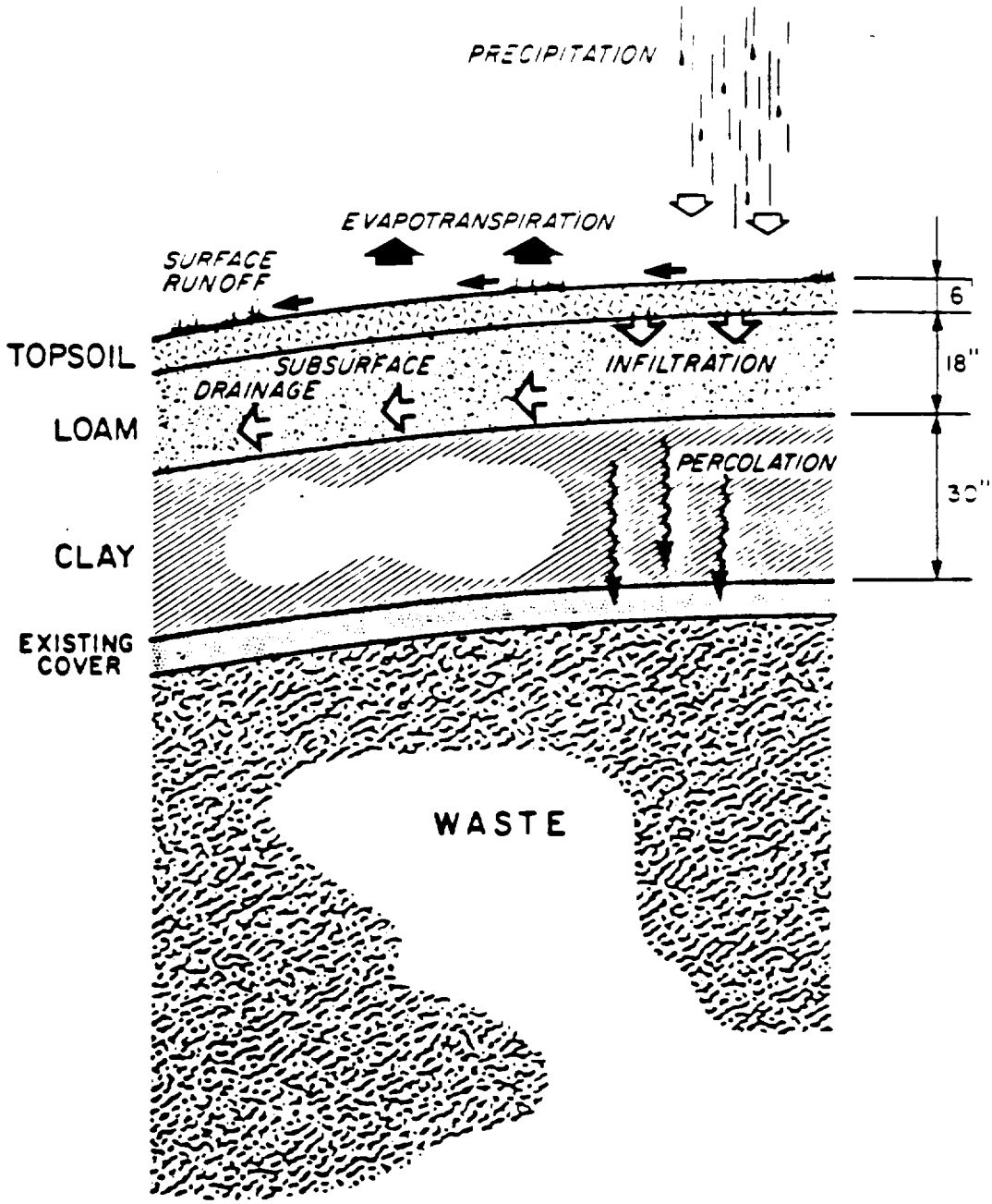

figure 6.2
FINAL COVER SCHEMATIC
A.L. TAYLOR SITE
Bullitt County, Kentucky

CRA

Geohydrologic studies of the site show that migration of contaminants off site is likely to be very slow. The annual volume of groundwater moving through the site is calculated to be low and assuming the fastest rate of groundwater flow, 2.41 feet/year, and no attenuation of contaminants in the site soils, any contaminant plume might take 20 years to move 50 feet.

A deep well drilled on site revealed up to 85 feet of unweathered shale isolating the limestone aquifer from the contaminated overburden. Pressure permeability tests performed on both shale units indicated little or no fracturing in the formations reducing the likelihood of contaminants moving into the deeper limestone aquifer.

Surface water, like groundwater, is not believed to be a severe potential exposure route. The Salt River drainage basin which drains into the Ohio River is not a source of drinking water in the vicinity of the Salt-Ohio River confluence. Louisville does get its drinking water from the Ohio River but at a location upstream of the Ohio-Salt River confluence. No other water intakes are located along the Ohio River for many miles downstream but even if there were, the dilution factor (a million fold) should be great enough to prevent any measurable effects.

Potential exposure through recreational use of surface waters also is low due to the dilution factor. Recreational use of the streams leading from the site, although not documented, is believed to be low until the Salt River confluence is reached.

ENFORCEMENT

On April 1986, the United States filed a cost recovery action pursuant to Section 107 of CERCLA; Section 311 of the Clear Water Act, and Section 7003 of the Resource Conservation and Recovery Act for emergency and other response costs incurred at the site since 1979. The lawsuit was filed in the United States District Court for the Western District of Kentucky against the current and past owners and operators of the site and four of the primary generators. The pending action was filed following the unsuccessful conclusion of negotiations concerning future remedial activities at the site. Additional cost recovery may be expected as future remedial activities are completed at the site.

COMMUNITY RELATIONS

Two public meetings were held to present the recommended remedial alternative. The first meeting was held on August 11, 1982 to discuss the modified onsite containment/excavate-and relocate alternative. Representatives of EPA, KDNREPC, local authorities, local media and the community were present. Discussions were held outlining the development of the alternatives and the selection process. Following the public meeting, 30-day comment period was given. All reports and data were left on file at the Bullitt county courthouse. No written comments were received.

Another public meeting was scheduled for presentation of the second remedial alternative recommendation. In this second meeting, held on June 16, 1983,

the onsite containment alternative was presented as the newly selected remedial alternative. As in the first meeting, community turnout was low and no written comments were received during the 30-day comment period following the public meeting.

ALTERNATIVE EVALUATION

Remedial alternatives evaluated at the A.L. Taylor Site are source control measures. The migration of hazardous substances from their original disposal area is minimal and the remedial alternatives considered are to control off-site migration.

The objectives of the remedial action are broad enough to address all routes of release but focus on those areas with the greatest potential for having adverse effects on public health and the environment. The remedy will also take into account cost-effective considerations. With these criteria, the following are the objectives for remedial action at the A.L. Taylor site:

1. The air quality will be protected by the control of emissions of particulate matter and toxic gases.

2. The recreational users and biota of downstream surface waters will be protected from leachate and contaminated runoff.

3. Groundwater, although low yielding and unpotable, contributes to surface water and will be protected by reducing aquifer recharge.

4. Local populations will be protected from direct contact with contaminated soils.

The following remedial alternatives were evaluated.

1. No Action

The no action alternative is not acceptable because the wastes would remain on site in an uncontrolled manner. The site would continue to pose a potential threat to Wilson Creek.

2. Minimum Action Alternative

This alternative consists of leaving all buried waste in place, regrading and revegetating the existing site surface, removing wastes from the open pit and surface dumping area northeast of the site, establishing a groundwater monitoring program, operating and maintaining the existing runoff collection and treatment system and preparing and filing a record plat. This alternative is developed as a base line comparison for the other alternatives and is not intended to meet the requirements of a RCRA facility.

3. Onsite Containment Alternative

The basic idea behind the onsite containment alternative is to isolate the

buried hazardous waste without disturbing the existing waste cells. The RCRA regulations governing a hazardous waste landfill will be used as guide lines where possible.

The alternative includes a slurry wall keyed to bedrock, clay soil cover, leachate/gas collection system, leachate treatment system, runoff/drainage diverson, revegetation, security fence and sign, and record plat.

4. Excavate-And-Relocate Offsite

This alternative includes excavating most of the onsite contamination, transporting it to an approved disposal facility and restoring the site. This alternative will be most effective in controlling long-term pollution levels at the site. The cost of this approach is strongly dependent on distance to the ultimate disposal site.

Ultimate disposal facilities costs for contaminated soils are given for comparison in the Table 15

5. Modified Onsite Containment/Excavate-And-Relocate

This alternative combines onsite containment and excavate-and-relocate to provide a hybrid alternative. One approach considered was removing only the free liquid in the waste pits but was rejected for cost reasons. The approach developed will remove the most toxic and highly polluted material on site. Both groundwater and surface water diversion will be provided, to prevent soil moisture, shallow groundwater, and surface water from contacting these contaminated materials and acting as a transport medium Groundwater diversion will be accomplished by a combination of upgradient slurry walls and french drains. Surface water diversion will be provided by a drainage method similar to the diversion ditch proposed in the onsite containment alternative. In addition to diversion, a landfill cap will prevent vertical infiltration of rainwater into the contaminated zone. The landfill cap consists of 2 feet of topsoil and clay. The site will be surrounded with a chain link fence and a locking gate for site security. Monitoring wells will be installed between the site and Wilson Creek. Operation and maintenance requirements at the site will be kept to a minimum. Leachate collection requirements have been eliminated. Annual maintenance of the site will consist of repair of erosion damage, mowing and revegetation. Annual monitoring of the sampling wells will be required.

6. Excavate-and-Relocate Onsite

This alternative consisted of excavation of all contaminants onsite and placing them in a cell constructed onsite which would conform fully with RCRA requirements.

A conceptual design of a landfill cell was developed for consideration as a remedial alternative. The scope of this study included a geophysical remote sensing investigation of two areas within the general site which were being considered for the construction of the land disposal cell. The quantities of buried wastes found during the second phase of this investigation indicated much more waste remained onsite than could safely be disposed of in this small landfill area.

7. Modified Onsite Containment Alternative (Potential Responsible Party)

Geosciences Research Associates, Inc. (GRA) and Tenech Environmental Engineers, Inc. (TEE) have developed a modified onsite containment approach at the A. L. Taylor Site for the PRPs. This approach is based on work performed by Ecology and Environment, Inc. (E&E). This alternative consisted of an impermeable cap and soil cover, drainage diversion ditch, groundwater monitoring well system, site clearing, regrading and revegetation, security fence and signs.

Where possible RCRA regulations governing a hazardous waste landfill will be used as guidelines. The proposed cap will prevent surface runoff contact with contaminated soil and the subsequent generation of contaminated runoff. The installation of upgradient diversion ditches will eliminate surface runon.

Upgradient monitoring wells will be installed on the site to augment the existing downgradient system. The proposed modified containment alternative would mitigate the threat to public health and the environment by eliminating the present routes of exposure.

Initial Alternatives Recommended - 1982

On August 11, 1982 a Decision Memorandum was issued from EPA Region IV recommending the modified onsite containment/excavate-and-relocate alternative. A review meeting was held August 23, 1982 to discuss the recommendation. The meeting resulted in EPA Headquarters requesting additional information to justify removal of wastes offsite. As the result of these further studies the Modified Onsite Containment/Excavate-and-Relocate alternative could not be justified under the cost-effective requirements of CERCLA. EPA Headquarters indicated that the onsite containment alternative should be considered in more detail.

During negotiations for the final remedy, the Potentially Responsible Parties (PRPs) submitted a conceptual design for the onsite containment alternative. This conceptual design differed from the onsite containment alternative presented in the feasibility study in that the leachate collection system and slurry wall had been eliminated. EPA, Region IV requested additional information before the conceptual design could be fully evaluated. A hydrogeologic investigation was conducted by the PRPs consultants. This information was included as an addendum to the feasibility study prepared under EPA contract by Metcalf & Eddy, Inc. (M & E) in August, 1984.

The addendum also included updated cost estimates for the alternatives developed by E & E and gave cost estimates for the onsite containment alternative as proposed by the PRPs. For comparison an estimate for the cost of constructing a RCRA landfill onsite was given, and an endangerment assessment was added. These cost estimates are included in Table 3-7.

Table 3 presents a comparison of the most significant criteria affecting the alternative selection process. The alternatives are compared using the evaluation criteria presented in the feasibility study. Table 13 presents each of the alternatives and the important facts relative to each comparative evaluation criteria: reliability, implementability, RCRA

conformance, safety and operation and maintenance.

Table 5 presents a summary of the proposed Remedial Alternative costs which includes capital cost for implementation of the remedy and the associated long-term monitoring costs.

In August 1985 the Potentially Responsible Parties (PRPs) submitted the conceptual design of the onsite containment alternative. EPA added the following changes:

1. to upgrade the proposed cap to conform with the guidelines of the Resource Conservation and Recovery Act (RCRA).

2. to install additional upgradient monitoring wells

3. to establish a long term operation and maintenance program that included a groundwater and surface water monitoring program, well maintenance, rehabilitation, cover, and cap maintenance.

4. Final slope of cover will be between three and five percent where possible.

The total cost with the additional EPA requirements added would be $713,250 for construction costs and $503,876 for O & M cost, with a total project cost of 1,217,126.

Recommended Alternative - 1986 (Alternative #7)

The selected remedy is consistent with the remedy first proposed in the EDD (1985) and is the most cost effective remedy which adequately protects the public health and welfare and the environment.

As a result of Negotiations with the Potentially Responsible Parties Committee, technical changes and considerations were made to the previously proposed remedy.

The selected remedy includes:

Removal of ponded water from the site.

Secure pond sediments, sludge and materials from low-lying areas beneath the cap.

Install final cap cover for containment of the waste materials.

Construct a surface water drainage diversion which will route surface water around the cap area and which can accommodate a 25 year/24 hour storm.

Implement a performance monitoring program on Wilson Creek (the only potential receptor of chemical migration) to evaluate the effectiveness of the clay cap to mitigate surface chemical migration.

Monitoring of groundwater quality will be accomplished by eight (8) newly installed nested wells placed along the Creek valley at four locations, to monitor both the shallow and the deeper groundwaters. In addition, these wells will provide an early warning of any contaminant movement toward Wilson Creek via groundwater, if groundwater is present.

Following the completion of the remedial construction, the site will be secured with the installation of a six foot high chain link fence with appropriate gates.

The site will be subject to a regular inspection and maintenance program following completion of remedial construction for a period of thirty (30) years.

The cover will consist of a 30- inch layer of clay to attain a permeability of 1 x 10 -7 cm/sec., followed by an 18-inch layer of material with a permeability between 10 -3 and 10 -5 cm/sec. A 6- inch layer of topsoil will be placed as final cover and vegetated with cover plants having root systems which will stabilize the top soil and loam against erosion but which will not penetrate the clay material of the cap.

The active contaminant migration pathway at the A.L. Taylor site is by surface water runoff. The final cover is proposed as a method of containing waste materials and preventing contact between surface water and waste.

RCRA Closure Standards

After review of the information, the decision was made that groundwater flow at the site is minimal, recharge rates are very slow and there are no residential (drinking) wells within miles of the site. Naturally occurring high levels of Mg & Ca in the groundwater also combine to make the groundwater marginally useful as a drinking water source. The naturally occurring soils fulfill the permeability requirements of RCRA closure standards.

RCRA Cap

The specifications for the RCRA cap are essentially the same as in the original remedy noted in the Feasibility Study. However, based on information supplied by the PRPs and review of the files, a flexible membrane liner does not appear to be needed at the A.L. Taylor Site. This decision was based on the very low permeability of the underlying materials.

Groundwater Monitoring Wells

Four (4) additional nested groundwater monitoring wells will be installed (2 at each location). Locations and specifications are in the project work plan.

The Remedial design of the final cover should accomplish the following objectives:

provide long-term minimization of migration of liquids through the final cover (to minimize leachate),

Function with minimum maintenance,

Promote drainage and minimize erosion or abrasion of the cover,

Accomodate settling and subsidence so that the cover's integrity is maintained,

Have a permeability less than or equal to the permeability of any bottom liner or natural subsoils present.

Listed below are programmed construction cost estimates.

PROGRAMMED CONSTRUCTION COST ESTIMATE

A. L. TAYLOR SITE REMEDIATION

PROJECT START-UP AND CLOSE-OUT	$ 28,500.00
HEALTH AND SAFETY	$ 22,000.00
SITE PREPARATION	$ 43,410.00
CAP PLACEMENT	$372,620.00
RESTORATION	$ 81,749.00
SUB-TOTAL	$548,279.00
CONTINGENCIES (25% of SUBTOTAL)	$137,070.00
ENGINEERING DESIGN, SUPERVISION AND CONTRACT MANAGEMENT	$110,000.00
TOTAL	$795,349.00

Remedial Alternative Analysis

The feasibility study for the A.L. Taylor site was initially developed by Ecology and Environment, Inc. (EE) in 1982. The study contained evaluations of minimum action, onsite containment, and excavate and relocate offsite alternatives. A modified alternative was subsequently developed. The modified onsite containment/excavate and relocate alternative was developed at the request of the KDNREP. This alternative was incorporated in the revised feasibility study. The following are the criteria used to assess the remedial options:

Reliability: This considers the extent to which a system, device, or technology will perform a desired function correctly for a number of repeated trials or for an extended period of time. Without test data to measure performance against an established standard, reliability of each alternative was based on scientific judgement. The alternatives were ranked as to their relative reliability without attempting to establish the quantitative reliability of each alternative.

Implementability: This is the physical, finanical and legal power to carry out the alternative. Because of the varied nature of the possible remedial alternatives, they were evaluated based on their ease of implementation. Consideration was given to public opinion, regulatory procedures, duration, scheduling, natural constraints (such as weather), and technical feasibility. The alternative that could be implemented most easily was given preference.

RCRA Conformance: Each alternative design was compared to new landfill design standards permitted under the Resource Conservation and Recovery Act (RCRA). The alternative which provided environmental protection performance similar, to a RCRA permitted landfill was given preference.

Environmental Concerns: These were identified for each alternative, and the alternative with the least adverse environmental impact received preference.

Safety Requirements: These were developed to mitigate the risks of construction of each alternative. Where necessary, risk assessments were made on each operation. The safety requirements and relative preference was given to the alternative having the lowest relative risk and least safety requirements.

Operation and Maintenance Efforts: Manpower and equipment requirements were identified for each alternative for a 30 year project period. Maintenance effort was based on parts replacement, corrosion control, and safety requirements when applicable. Operation personnel, utility cost, and major system replacement requirements for each alternative were developed. Preference was given to the alternative with the least long term commitment of capital, manpower, and equipment.

Table 14 presents a comparison of the most significant criteria affecting the alternative selection process. The alternatives are compared using the evaluation criteria presented in the feasibility study. Table 13 presents each of the alternatives and the important facts relative to each comparative evaluation criteria: reliability, implementability, RCRA conformance, safety, and operation and maintenance.

Table 1 presents a summary of the proposed Remedial Alternative costs which includes capital costs for implementation of the remedy and the associated long-term monitoring costs.

Consistency With Other Environmental Laws

-Clean Water Act is a state delegated program and the Commonwealth has not stated any objections to the selected alternative.

-There are no impacts to the air in the area therefore the remedy will comply with the Clean Air Act.

-No proposed actions will require TSCA compliance.

-Resource Conserative and Recovery Act (RCRA) staff have been contacted and state no objection to the proposed remedy.

Operation and Maintenance (O & M)

O & M costs at this site will be the collection and analysis of groundwater and surface water samples, maintenance of the fence, cap, vegetated cover and monitoring wells over a period of 30 years. The Commonwealth will assume these functions one year after completion of construction.

Funding

It is recommended that this remedy be funded at 10% Commonwealth funds, 90% Federal Funding.

Schedule

June 18, 1986	Sign Record of Decision
June 30, 1986	Initiate Remedial Design
March 31, 1987	Complete Design
September 1, 1987	Initiate Construction
September 1, 1987	Complete Construction

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APPENDIX

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TABLE 1. SUMMARY OF PROPOSED REMEDIAL ALTERNATIVE COSTS

Alternative	Capital Cost	O&M Costs	O&M Costs[1]	Total Costs[2]
E&E Minimum Action Alternative	$157,000	$114,676	$332,200	$489,200
E&E Onsite Containment Alternative	$602,000	$239,290	$704,000	$1,306,000
E&E Excavate-and Relocate Alternative	$2,934,000	$86,396	$242,200	$3,176,200
PRP Consultant Onsite Containment Alternative	$531,875	$114,676	$332,200	$864,075
RCRA Landfill Alternative	$1,423,100	$294,656	$890,300	$2,313,400
RCRA Offsite Disposal Alternative #1	$4,359,425	-	-	$4,359,425
RCRA Offsite Disposal Alternative #2	$5,497,285	-	-	$5,497,285

1. These costs assume that the cost escalation factor is the same as the interest rate, 10%.
2. The total cost includes the O&M costs with the cost escalation factor the same as the interest rate.

TABLE 2 ORGANIC CHEMICAL CONCENTRATIONS IN GROUNDWATER. A. L. TAYLOR SITE

	Test Pit Liquid[1] 1979		Test Soil Borings[2] 1982	
	Average Condition		(Std. Deviation) ug/l	
Acenapthene	36,000	(80,498)	--	
Anthracene/Phenanthrene	34,000	(76,026)	--	
Bis (2-ethylhexyl) Phthalate	580,641	(1,296,562)	--	
Ethyl Benzene	7,704	(10,106)	1,150	(2,371)
Methyl Ethyl Ketone	7,940	(10,926)	--	
Methyl Isobutyl Ketone	9,976	(12,985)	--	
Napthalene	240,020	(536,645)	38	(28)
Toluene	11,980	(10,643)	1,642	(1,879)
Trans 1,2-Dichloroethylene	33,680	(70,648)	302	(598)
Vinyl Chloride	989	(1,264)	30	(60)
Xylene	2,212,360	(4,912,446)	NQ[3]	

1. U.S. EPA, 1979a. Liquid found in test pits dug by backhoe in principal area suspected of containing buried wastes. A-4, A-5, A-6, A-7, A-10. When no value was reported for a given site, zero concentration was assumed.
2. U.S. EPA, 1982c. Test wells drilled downgradient of same principal burial area. Average of K-16, L-14, L-12, L-11. When not detected in a given test well, zero ug/l was assumed.
3. NQ - Detected but not quantified.

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TABLE 3 UPDATE OF E&E CONSTRUCTION COST ESTIMATE FOR THE MINIMUM ACTION ALTERNATIVE

Item	Cost, Thousand Dollars 1982 Lower	1982 Upper	1984 Lower	1984 Upper
Pit and Surface Dumping:				
Excavation & Backfill	12.6	18.9	13.5	20.2
Transport & Disposal	51.7	79.5	55.3	85.1
Site Rehabilitation (Minor grading, fertilizing, trees, seeding & mulching)	4.0	5.0	4.3	5.4
Wastewater treatment renovation/ operation/disassembly*	26.8	68.6	28.7	73.4
Monitoring Wells	10.5	10.5	11.2	11.2
Security & Safety, Plat Survey & Legal Fees	2.0	3.0	2.1	3.2
Warning Signs	0.1	0.1	0.1	0.1
TOTAL	107.7	185.6	115.2	198.6

* The wastewater treatment system will be renovated so that the lagoon water can be treated. Once the lagoon water is treated, the system will be disassembled and shipped to the KDNREP.

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TABLE 4 UPDATE OF E&E CONSTRUCTION COST ESTIMATE FOR THE ONSITE CONTAINMENT ALTERNATIVE

	Cost, Thousand Dollars			
	1982		1984	
Item	Lower	Upper	Lower	Upper
Slurry Wall	70	120	75	128
Clay Cap	52	102	56	109
Topsoil Cover	60	100	64	107
Drainage Diversion Channel	4	7	4	7
Monitoring Wells (1-up;3 down)	8	13	9	14
Leachate Collection System	43	72	46	77
Wastewater treatment renovation/ operation/disassembly	207	69	29	73
Site Grooming, Clearing, Grubbing & Initial Revegetation	4	7	4	7
Security Fence, Gate, Signs	28	46	30	49
Utilities Installation	1	1	1	1
Record Plat	3	4	3	4
Project Management, Monitoring, Sampling and Permitting	40	60	43	64
SUB-TOTAL	340	601	364	640
Undefined Details & Contingencies (20%)	68	120	73	128
TOTAL	408	721	437	768

TABLE 5 UPDATE OF E&E CONSTRUCTION COST ESTIMATE FOR THE EXCAVATE-AND-RELOCATE ALTERNATIVE

	Cost, Thousand Dollars			
	1982		1984	
Item	Lower	Upper	Lower	Upper
Agency Management	5	12	5	13
Project Management	15	32	16	34
Pre-Excavation Sampling and Permitting	29	29	31	31
Mobilization	17	17	18	19
Excavation	85	204	91	218
Pollution Control*	68	151	73	162
Backfilling & Topsoil	80	179	86	192
Closure	29	32	31	34
Utilities	1	1	1	1
SUBTOTAL	329	657	352	704
Undefined Details (10%)	33	66	35	70
Contingencies (10%)	33	66	35	70
SUBTOTAL	395	789	422	844
Transport & Disposal	1,000	3,300	1,070	3,531
TOTAL	1,395	4,089	1,492	4,375

* E&E has included the wastewater treatment costs in this item.

TABLE 6 SUMMARY OF CONSTRUCTION COST ESTIMATE FOR PRP CONSULTANT REMEDIAL ALTERNATIVE

Technology	Cost
Site Clearing	$7,930
Renovation of Treatment System	$39,200
Processing Lagoon Water	$7,000
Removal of Renovated Treatment System	$9,800
Diversion Trench Installation	$39,875
Site Grading	$22,820
Monitoring Well System	$18,200
Site Cover and Cap	$313,150
Revegetation	$28,300
Security Fence and Signs	$40,600
Record Plat	$5,000
	$531,875

TABLE 7 SUMMARY OF CONSTRUCTION COST ESTIMATE FOR A NEW RCRA LANDFILL

Technology	Cost
Site Clearing	$7,930
Renovation of Treatment System	$39,200
Processing Lagoon Water	$7,000
Removal of Renovated Treatment System	$9,800
Excavation and On-Site Storage of Site Soils	$420,000
Diversion Trench Installation	$39,875
Bottom Liner and Leachate Control	$234,080
Monitoring Well System	$25,200
Site Cover and Cap	$573,525
Revegetation	$21,500
Security Fence and Signs	$40,000
Record Plat	$5,000
	$1,423,110

TABLE 8 PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS-MINIMUM ACTION ALTERNATIVE

1. Sampling/analytical costs:	
P/A - 1st year - $18,000	$16,364
P/A - 4 years - $9,000/year = $28,530	
P/F - 1 year - $28,530	$25,936
P/A - 25 years - $6,000/year = $54,420	
P/F - 5 years - $54,420	$33,790
2. Replacement of Monitoring Wells	
P/F - 15 years - $18,200	$4,358
3. Well Maintenance and Rehabilitation	
P/A - 50% - 5 - $4,000	
P/F - 5, 10, 15, 20, 25 years - $4,000	$5,948
4. Cover and Cap Maintenance	
P/A - 30 years - $3,000	$28,280
	$114,676

1. Assume: 10% interest.

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1454-A

TABLE 9 PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS-ONSITE CONTAINMENT ALTERNATIVES

1. Leachate management system*	
P/A - 30 years - $9,000/year	$ 84,834
2. Sampling/analytical costs:	
P/A - 1st year - $18,000	16,364
P/A - 4 years - $9,000/year = $28,530 P/A - 1 year - $28,530	25,936
P/A - 25 years - $6,000/year = $54,420 P/F - 5 years $54,420	33,790
3. Replacement of Monitoring Wells	
P/F - 15 years - $18,200	4,358
4. Well Maintenance and Rehabilitation	
P/A - 50% - 5- $4,000 P/F - 5, 10, 15, 20, 25 years - $4,000	5,948
5. Cover and Cap Maintenance	
P/A - 30 years - $3,000	28,280
6. Gas Monitoring	
P/A - 1 year - $12,000/year	10,900
7. Miscellaneous (utilities, surface water control maintenance)	
P/A - 30 years - $3,000/year	28,280
	$239,290

1. Assume: 10% interest

* The operation and maintenance costs for the leachate management system include depreciation costs for the leachate pump and storage tank, $1,200 per year, and the offsite shipment and disposal of 120 55 gallon drums of leachate per year at a cost of $65 per drum.

TABLE 10 PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS-EXCAVATE-AND-RELOCATE ALTERNATIVE

1. Sampling/analytical costs:	
P/A - 1st year - $18,000	$16,364
P/A - 4 years - $9,000/year = $28,530'	
P/F - 1 year - $28,530	25,936
P/A - 25 years - $6,000/year = $54,420	
P/F - 5 years - $54,420	33,790
2. Replacement of monitoring Wells	
P/F - 15 years - $18,200	4,358
3. Well Maintenance and Rehabilitation	
P/A - 50% - 5 - $4,000	
P/F - 5, 10, 15, 20, 25 years - $4,000	5,948
	$86,396

1. Assume: 10% interest

TABLE 11 PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS - PRP CONSULTANT ALTERNATIVE

1. Sampling/analytical costs:	
P/A - 1st year - $18,000	$16,364
P/A - 4 years - $9,000/year = $28,530	
P/F - 1 year - $28,530	$25,936
P/A - 25 years - $6,000/year = $54,420	
P/F - 5 years - $54,420	$33,790
2. Replacement of Monitoring Wells	
P/F - 15 years - $18,200	$4,358
3. Well Maintenance and Rehabilitation	
P/A - 50% - 5 - $4,000	
P/F - 5, 10, 15, 20, 25 years - $4,000	$5,948
4. Cover and Cap Maintenance	
P/A - 30 years - $3,000	$28,280
	$114,676

1. Assume: 10% interest

TABLE 12 PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS - RCRA LANDFILL

1.	Leachate Management System*	
	P/A - 30 years - $9,000/year	$84,834
2.	Sampling/analytical costs:	
	P/A - 1st year - $26,000	$23,636
	P/A - 4 years - $13,000/year = $41,207	
	P/F - 1 year - $41,207	$37,460
	P/A - 25 years - $8,600/year = $78,000	
	P/F - 5 years - $78,000	$48,431
3.	Replacement of Monitoring Wells	
	P/F - 15 years - $27,300	$6,535
4.	Well Maintenance and Rehabilitation	
	P/A - 50% - 5 - $6,000	
	P/F - 5, 10, 15, 20, 25 years - $6,000	$8,900
5.	Cover and Cap Maintenance	
	P/A - 30 years - $3,000/year	$28,280
6.	Gas Monitoring	
	P/A - First year - $12,000/year	$10,900
7.	Miscellaneous (utilities, surface water control maintenance)	
	P/A - 30 years - $3,000/year	$28,280
		$277,276

1. Assume: 10% interest.

* The operation and maintenance costs for the leachate management system include depreciation costs for the leachate pump and storage tank, $1,200, and the offsite shipment and disposal of 120 55 gallon drums of leachate per year at a cost of $65 per drum.

TABLE 13

COMPARISON EVALUATION CRITERIA

ITEM	ALTERNATIVE		
	MINIMUM ACTION	ONSITE CONTAINMENT	EXCAVATE-AND-RELOCATE OFFSITE
Reliability	Waste remains Natural containment of limited certainty Treatment plant overflows occasionally Long-term commitment to maintenance and monitoring	Waste remains 4 of 4 release pathways contained Treatment plant eliminated Long-term commitment to maintenance and monitoring	Waste removed 4 of 4 release pathways controlled Treatment plant eliminated Minor long-term commitment to monitoring
Implementability	Technically possible Needs technical expertise at WTP Needs owner permission Potential community opposition Zoning of WTP needed	Technically possible Limited technical skills needed Need owner permission Potential community support	Technically possible Limited technical skills required Landowner's consent likely Potential community support
RCRA Conformance	Does not conform	Conforms except for no botton liner	Conform by placement of waste in RCRA facility
Safety	Minor risks of fire, explosion, toxic gas release or spill	No risk of fire, explosion, toxic gas release or spill	No risk of fire or explosion; medium risk of toxic gas release or spill

(a)

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TABLE 13
(CONTINUED)
COMPARISON EVALUATION CRITERIA

ITEM	ALTERNATIVE		
	MINIMUM ACTION	ONSITE CONTAINMENT	EXCAVATE-AND-RELOCATE OFFSITE
Operation & Maintenance	Major commitment of manpower and money for 5 years Significant maintenance for 30 years Monitoring for 30 years	Significant maintenance for 30 years Monitoring for 30 years	Significant maintenance for 5 years Monitoring for 30 years
Environmental Protection	Does not control air emissions Limited control of surface runoff No control of groundwater No control of direct contact	Control of air emissions Control of surface runoff Control of groundwater Control of direct contact	Control of air emissions Control of surface runoff Control of groundwater Control of direct contact

(b)

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TABLE 13

COMPARISON EVALUATION CRITERIA

ITEM	ALTERNATIVE	
	MODIFIED ONSITE CONTAINMENT EXCAVATE-AND-RELOCATE	EXCAVATE-AND-RELOCATE ONSITE
Reliability	Waste removed 4 of 4 release pathways controlled treatment plant eliminated minor long-term commitment to monitoring	Waste removed excavation of all contaminants placing them in a cell constructed onsite which would conform fully with RCRA requirements. Results of a geophysical investigation showed that the size of a disposal cell that could be constructed on site in a suitable area had insufficient capacity material buried at the site.
Implementability	Technically possible limited technically skills required landowner's consent likely potential community support	Technically not possible due to insufficient land capacity to contain the material
RCRA Conformance	Conforms except for no bottom liner	Conforms except for no bottom liner
Safety	No risk of fire or explosion; medium risk of toxic gas release or spill	No risk of fire or explosion; medium risk of toxic gas release or spill

(c)

ALT 001 001460

TABLE 13

COMPARISON EVALUATION CRITERIA

ITEM	ALTERNATIVE	
	MODIFIED ONSITE CONTAINMENT/ EXCAVATE-AND-RELOCATE	EXCAVATE-AND-RELOCATE ONSITE
Operation & Maintenance	Significant maintenance for 5 years; monitoring for 30 yeras	Significant maintenance for 5 years; monitoring for 30 years
Environmental Protection	Control of air emissions Control of surface runoff Control of groundwater Control of direct contact	Control of air emissions Control of surface runoff Control of groundwater Control of direct contact

(d)

ALT 001 001461

TABLE 13

COMPARISON EVALUATION CRITERIA

ITEM	ALTERNATIVE	
	MODIFIED ONSITE CONTAINMENT EXCAVATE-AND-RELOCATE	EXCAVATE-AND-RELOCATE OFFSITE
Reliability	Waste removed 4 of 4 release pathways controlled treatment plant eliminated minor long-term commitment to monitoring	Waste removed excavation of all contaminants placing them in a cell constructed onsite which would conform fully with RCRA requirements. Results of a geophysical investigation showed that the size of a disposal cell that could be constructed on site in a suitable area had insufficient capacity material buried at the site.
Implementability	Technically possible limited technically skills required landowner's consent likely potential community support	Technically not possible due due to insufficient land capacity to contain the material
RCRA Conformance	Conforms except for no bottom liner	Conforms except for no bottom liner
Safety	No risk of fire or explosion; medium risk of toxic gas release or spill	No risk of fire or explosion; medium risk of or spill toxic gas release or spill

(e)

ALT 001 001462

TABLE 13

COMPARISON EVALUATION CRITERIA

ITEM	ALTERNATIVE: MODIFIED ONSITE CONTAINMENT ALTERNATIVE (POTENTIALLY RESPONSIBLE PARTIES)	ALTERNATIVE: ONSITE CONTAINMENT POTENTIALLY RESPONSIBLE PARTIES
Operation & Maintenance	Significant maintenance for 5 years; monitoring for 30 years	Significant maintenance for 5 years; monitoring for 30 years
Environmental Protection	Control of air emissions Control of surface runoff Control of groundwater Control of direct contact	Control of air emissions Control of surface runoff Control of groundwater Control of direct contact

(f)

ALT 001 001463

TABLE 14

DECISION MATRIX OF MOST SIGNIFICANT
SELECTION CRITERIA

ELEMENTS OF COMPARISON	(1) MINIMUM ACTION	(2) ONSITE CONTAINMENT	(3) EXCAVATE AND RELOCATE	(4) PRP ONSITE CONTAINMENT (a)
Long-Term Release Control				
Air	Slight	Yes	Yes	Yes
Surface Runoff	Slight	Yes	Yes	Yes
Groundwater	No	Yes	Yes	Yes
Direct Contact	No	Yes	Yes	Yes
Life Cycle Cost	Least	Middle	Most	Less than Option (2)
RCRA Conformance	No	Potentially Yes (b)	Yes	Potentially Yes (c)
Reliability	Poor	Excellent	Superior	Excellent
Operation & Maintenance Cost	Most	Middle	Least	Middle

a. Onsite containment modified by elimination of slurry wall and leachate collection

b. Assuming integrity of shale layer.

c. Weathered shale may serve as a slow to medium release mechanism for limited quantities of shallow ground-water.

TABLE 15

ULTIMATE DISPOSAL FACILITIES FOR CONTAMINATED SOILS

LANDFILL	HAUL DISTANCE (one-way miles)	DISPOSAL COST (dollar/yd^3)
B.H.S., Inc. Wright City, Missouri	331	48.90
CECOS Cincinnati, Ohio	136	80.00
Chemical Waste Management Emelle, Alabama	515	50.00
U.S.Ecology Sheffield, Illinois	450	178.00
Adams Center Landfill Ft. Wayne, Indiana	273	40.00
Incinerator		
LWD, Inc. Paduka, Kentucky	240	250.00

TABLE I

REMEDIAL ALTERNATIVES FOR THE A. L. TAYLOR SITE

ALTERNATIVE	#1 MINIMUM ACTION	#2 ON-SITE CONTAINMENT	#3 EXCAVATE AND REMOVAL	#4 MODIFIED REMOVAL
Description	(1) Leave all buried wastes in place (2) Regrade and revegetate the existing site surface (3) Remove wastes from the open pit and surface dumping area (4) Establish a groundwater monitoring program (5) Operate and maintain the existing runoff collection and treatment system (6) Prepare and file a record plat	(1) Install total slurry wall around waste site (2) Install clay cap and soil cover (3) Install leachate/gas collection system (4) Operate leachate treatment system (5) Install runoff/drainage diversion ditches (6) Revegetate (7) Install security fence and signs	(1) Remove all contaminated materials from waste cells, open pit, and surface dumping area. Transport to RCRA disposal facility (2) Backfill all excavated areas with truck-in fill (3) Regrade and revegetate the site (4) Prepare and file a record plat	(1) Remove contaminated materials from main disposal trench, open pit, and surface dumping area. Transport to RCRA facility (2) Backfill (3) Install upgradient slurry wall and french drain (4) Install clay cap and soil cover (5) Install surface water diversion ditches (6) Revegetate (7) Install security fence and sign (8) Install remedial monitoring wells (9) Prepare and file a record plat
	#5 EXCAVATE AND RELOCATE ON-SITE	#6 MODIFIED ON-SITE CONTAINMENT (PRPs) PLUS EPA REQUIREMENTS UPGRADE TO RCRA CAP & LINER Construction & O&M Cost - 1,217,126	#7 MODIFIED ON-SITE CONTAINMENT (PRPs) Construction Cost - 795,349	
Construction Cost Range:	$ 119,000 - $211,500	$428,000 - $902,000	$1,589,000 - $4,641,000	$1,140,000
Midpoint:	$165,310	$665,000	$3,115,000	
Operation and Maintenance Cost: Range:	5 years: $38-$79,000	1st year: $43-$77,000 After 1st year:	1st year: $20-$31,000 After 1st year:	1st year $20-$34,000 After 1st year:

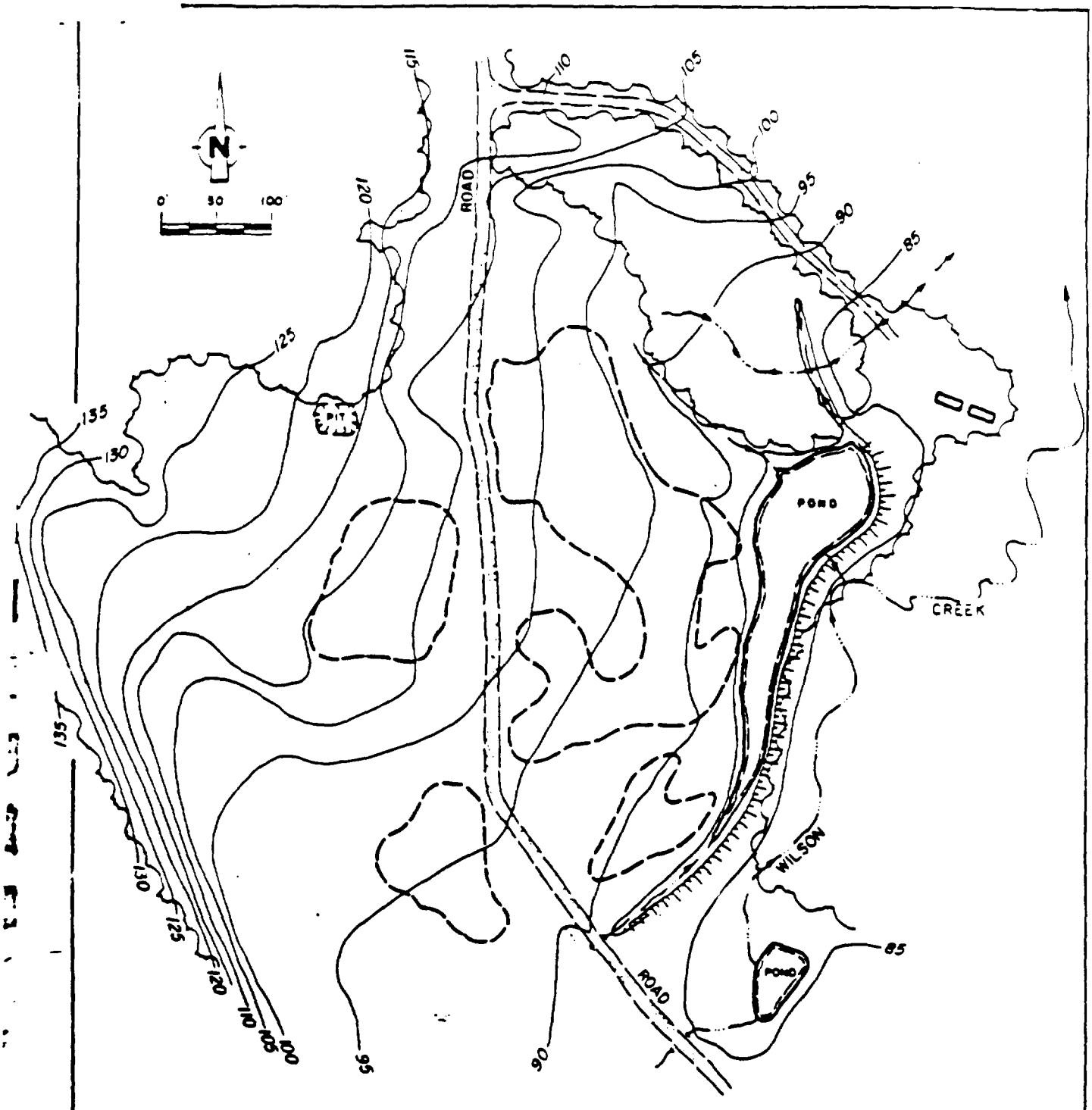
TABLE 2.1

SUMMARY OF SITE PERMEABILITIES

Formation	Horizontal Permeability (cm/sec.)	Vertical Permeability (cm/sec.)
Alluvium/colluvium	1.8×10^{-6} to 5.3×10^{-6}	2.5×10^{-7} to 7.0×10^{-7}
Residuum	--	4.5×10^{-7} to 1.7×10^{-8}
Weathered Shale	3.3×10^{-5} to 9.1×10^{-6}	2.0×10^{-7} to 4.5×10^{-7}
New Providence (Unweathered Shale)	--	6.3×10^{-8}

Notes: (1) Horizontal permeabilities determined from well response tests.
(2) Vertical permeabilities determined from laboratory permeability tests.

Source: Geosciences Research Associates, 1984.



LEGEND

- - - — — SUSPECTED WASTE DISPOSAL AREA

110 ——— TOPOGRAPHIC CONTOURS

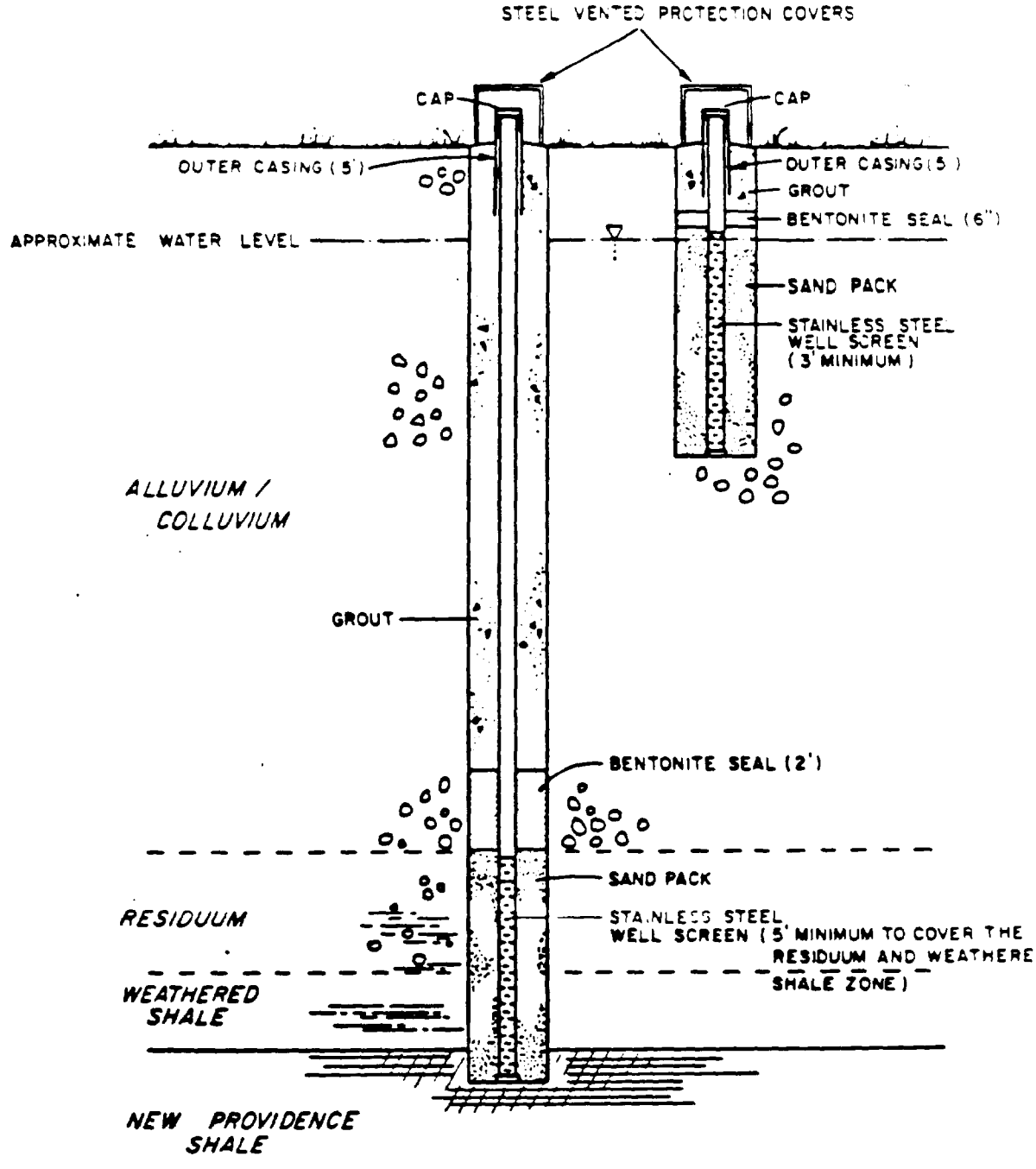
MAP MODIFIED FROM TENECH, SEPTEMBER 1983, FINAL DESIGN REPORT

CRA

figure 2.2

SITE MAP
A.L. TAYLOR SITE
Bullitt County, Kentucky

17:5 - 20/11/85



SOURCE: GEOSCIENCES RESEARCH ASSOCIATES, INC.

figure 3.3

TYPICAL MONITORING WELL CLUSTER
A.L. TAYLOR SITE
Bullitt County, Kentucky

CRA

1716 - 20/11/86

Reference 11

B&V WASTE SCIENCE AND TECHNOLOGY CORP.

TELEPHONE MEMORANDUM

USEPA Region IV
Jefferson Forest Drum Site
Property Ownership

BVWST Project 52009.049
BVWST File D.2
September 23, 1993
9:45 a.m.

To: Don Stevenson, Map Room
Company: Jefferson County Property Valuation Department
Phone No.: 502-625-6380

Recorded by: John Nett

I requested information on property ownership for the land parcel located west of the intersection of Kentucky State Route 1020 (Brooks Road) and the Jefferson County line. Mr. Stevenson pulled the aerial map used by the department to identify lots and property owners. Mr. Stevenson stated that the area of interest includes 3 to 4 acres of land shown to be in Jefferson County and approximately 100 acres shown to be in Bullitt County. Jefferson County currently does not collect taxes on the property shown to be in Bullitt County.

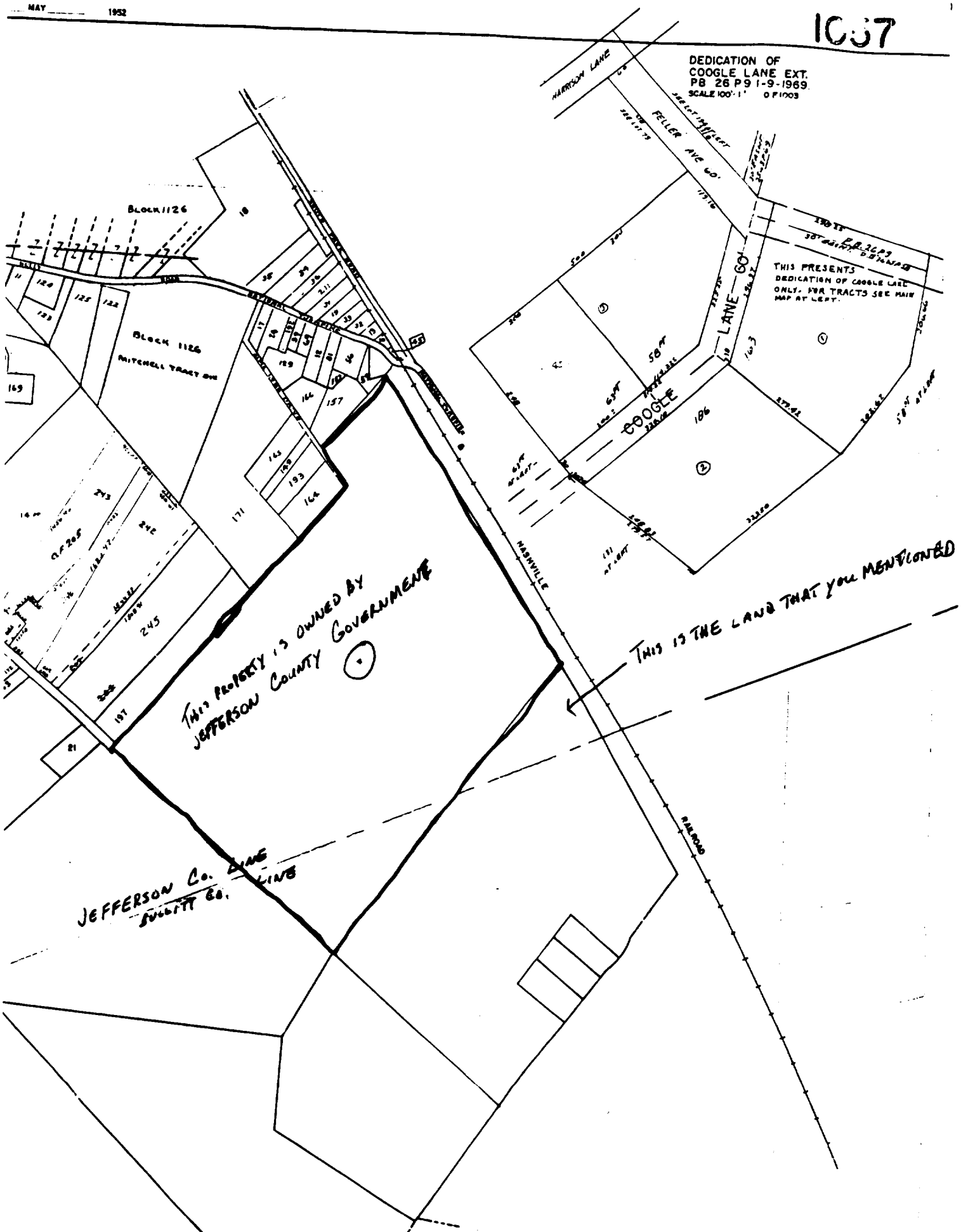
The department does not use the map system prepared by the State of Kentucky Tax Valuation Department. The department is in the process of switching to the "Logic" mapping system. The parcel of interest has not been assigned a property ID number, but will be assigned a number following transition to this new system.

Mr. Stevenson stated he would send me a copy of property map showing the area of interest. (The copy is attached to this memo).

John Nett
9/23/93

RGE C. TRAGER
COUNTY TAX COMMISSIONER
MAY 1952

1037



WESTON 1575 Northside Dr., N.W., Suite 325, Bldg. 300, Atlanta, GA 30318 404-352-4147

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE REMOVAL AND PREVENTION
EPA CONTRACT 68-WO-0036

MEMORANDUM

TO: Charlie Stevens
OSC, Region IV

FROM: Matthew Manka
TAT, Region IV

THRU: Donnissa L. Duvic
TATL, Region IV

SUBJECT: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky
TDD# 04-9212-0012-4186
0012A-4288
TAT# 04-F-00958

DATE: 31 March 1993

SITUATION

This report has been prepared in accordance with the requirements of Technical Direction Document (TDD) #04-9212-0012, issued to the Roy F. Weston, Inc., Technical Assistance Team (TAT) Louisville, Kentucky Satellite Office, by Region IV of the U.S. Environmental Protection Agency (EPA).

On 10 February 1993, On-Scene Coordinator (OSC) Charlie Stevens mobilized TAT members Manka and Maybriar to an area of the Jefferson County Memorial Forest near Brooks, Bullitt County, Kentucky (Figure 1 & 2 - Regional and Site Location Maps). This action was in response to a request from the Kentucky Department of Waste Management to investigate a number of drums abandoned in the forest. Some of the drums appeared to have leaked their contents onto the ground. The purpose of the investigation was to determine if additional drums were buried in conjunction with the exposed drums. The site in question lies in close proximity to the A. L. Taylor Drum Site.

SUMMARY

OSC Stevens tasked the TAT to subcontract exploratory excavation services. Six contractors were solicited and the job was awarded to Heritage Remediation/Engineers, Inc. (Heritage), which submitted the lowest bid for the requested services. TAT members Manka and Maybriar met Heritage personnel at the site on the morning of 10 February 1993 (Attachment A - Table of Witnesses). Heritage moved their equipment to the site and set up the hot zone and decontamination area. The area of concern was a small hillside that had several exposed and partially exposed drums along its slope. A couple of the drums had leaked what appeared to be paint waste. Most of the drums were very weathered and many were either rusted through or had bullet holes in them. There was a small amount of household trash throughout the area.

OSC Gail Scogin arrived at 0945 and toured the site. A work scope and safety meeting was held (Attachment B - Safety Plan). The Heritage crew then dressed out in level B and began work. Manka also dressed out in level B to perform air monitoring. Heritage started at the western end of the drum pile and excavated back into the hillside in order to determine the extent and size of the drum pile (Attachment D - Photographs). Excavation terminated at each point when native soil was uncovered and no further debris was found. The excavator worked its way eastward along the hillside. At 1015 hours, representatives from the Kentucky Department for Environmental Protection arrived onsite, met with the OSC and walked the hillside to check for previously undiscovered areas of drums. Maybriar and the OSC then switched out with Manka and continued air monitoring. During the excavation activities, three drums were discovered which contained liquids (Attachment E - Drum Logs). These drums were staged together within the work zone. Air monitoring within the drums revealed elevated readings in two of the three drums. The rest of the drums unearthed were empty. At approximately 1200 hours, OSC Dora Ann Johnson arrived and was briefed.

After the length of the hillside had been excavated, the OSC directed Heritage to dig a trench approximately four feet deep along the top of the hill as a secondary check of how far into the hill the drums extended. No drums were discovered and the trench revealed only native soil and some surface debris at the east end. The trench was then backfilled with the excavated soils. The OSC then had Heritage dig an additional trench approximately 100 yards east-northeast of the hill in an area where state representatives registered high magnetometer readings. No abnormalities were discovered and the trench was backfilled.

Following the trenching activities, Heritage segregated the metal debris into piles and crushed the empty drums with the bucket of the excavator. Manka and Maybriar dressed out in level B to collect samples of the liquids inside the drums. The drums were sampled and logged (Attachment E). The first drum contained approximately seven gallons of a gray substance which registered 45

parts per million (ppm) on the photoionization detector. The second drum contained about 10 gallons of a bright green liquid and the last drum contained 15-20 gallons of what appeared to be old oil. Neither of the last two drums emitted vapors in detectable amounts. Two sediment samples were collected from the bed of an intermittent steam located south of the hillside which could possibly receive runoff from the hill. One sample was from an upgradient location and the other from a downgradient location. One final sample, which consisted of an unidentifiable white powder, was collected from some of the debris uncovered during the excavation. The samples were labeled JCF-01 through JCF-06. The sampled drums were then covered with plastic sheeting and wrapped with caution tape. Sampling and excavation equipment was thoroughly deconned and the decon water was returned to the work zone. At 1730 hours, all parties demobed from the site.

On 11 February 1993, the samples were packaged and shipped to the Roy F. Weston, Inc. Laboratory in Stockton, California. The sediment samples (JCF-01 and -02), the powdered substance (JFC-03) and the liquid samples (JFC-04 and -05) were analyzed for extractable organics, TAL metals, and volatile organic compounds. The liquid sample numbered JFC-05 underwent a phase separation before it was analyzed and, at the OSC's request, the analyses were run on both phases. The remaining liquid sample (JFC-06) was analyzed for PCBs, in addition to the above parameters.

CONCLUSIONS

Laboratory analysis of the samples collected during the investigation did not reveal any significant environmental impact on the area. Compounds in the soil samples were within background levels. The powdered substance had an elevated level of lead. The liquid samples contained compounds typical of petroleum distillates. PCBs were not discovered in sample JFC-06 (See Attachment F for complete analytical results and tables). Any further action at the site will be determined by the OSC following a review of the analytical data.

ATTACHMENT

Figures 1-3 Maps & Sketches
Attachment A - Photographs
B - Log Notes
C - Table of Witnesses
D - Site Safety Plan
E - Drum Log
F - Analytical Analysis

FIGURE 1

General Site Map

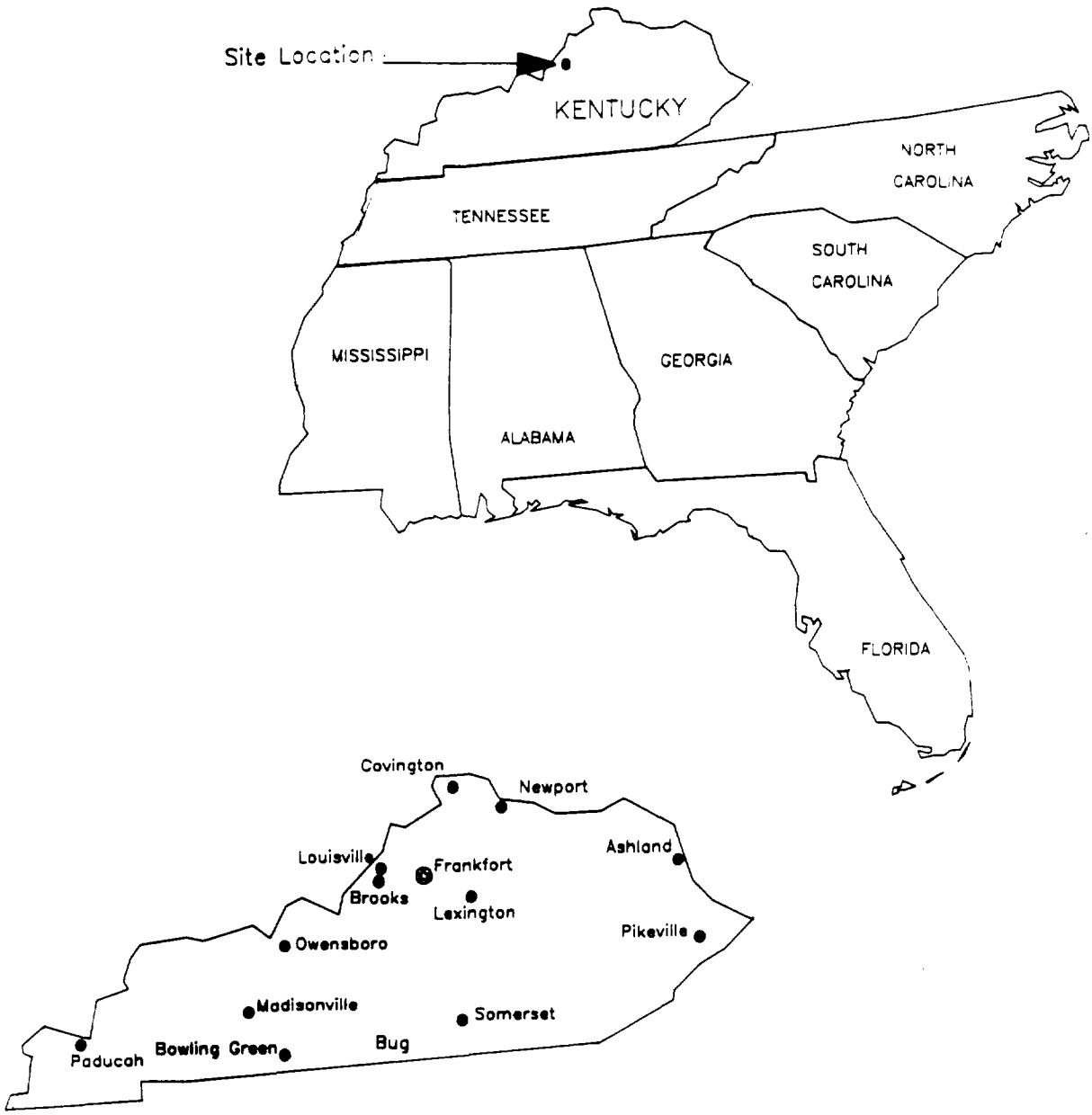


Figure 1

Weston T.A.T. Activity Location

TDD #04-9212-0012-4186

Jefferson Forest Drum Site

Brooks, Bullitt County, Kentucky

EPA

FIGURE 2

Area Location Map

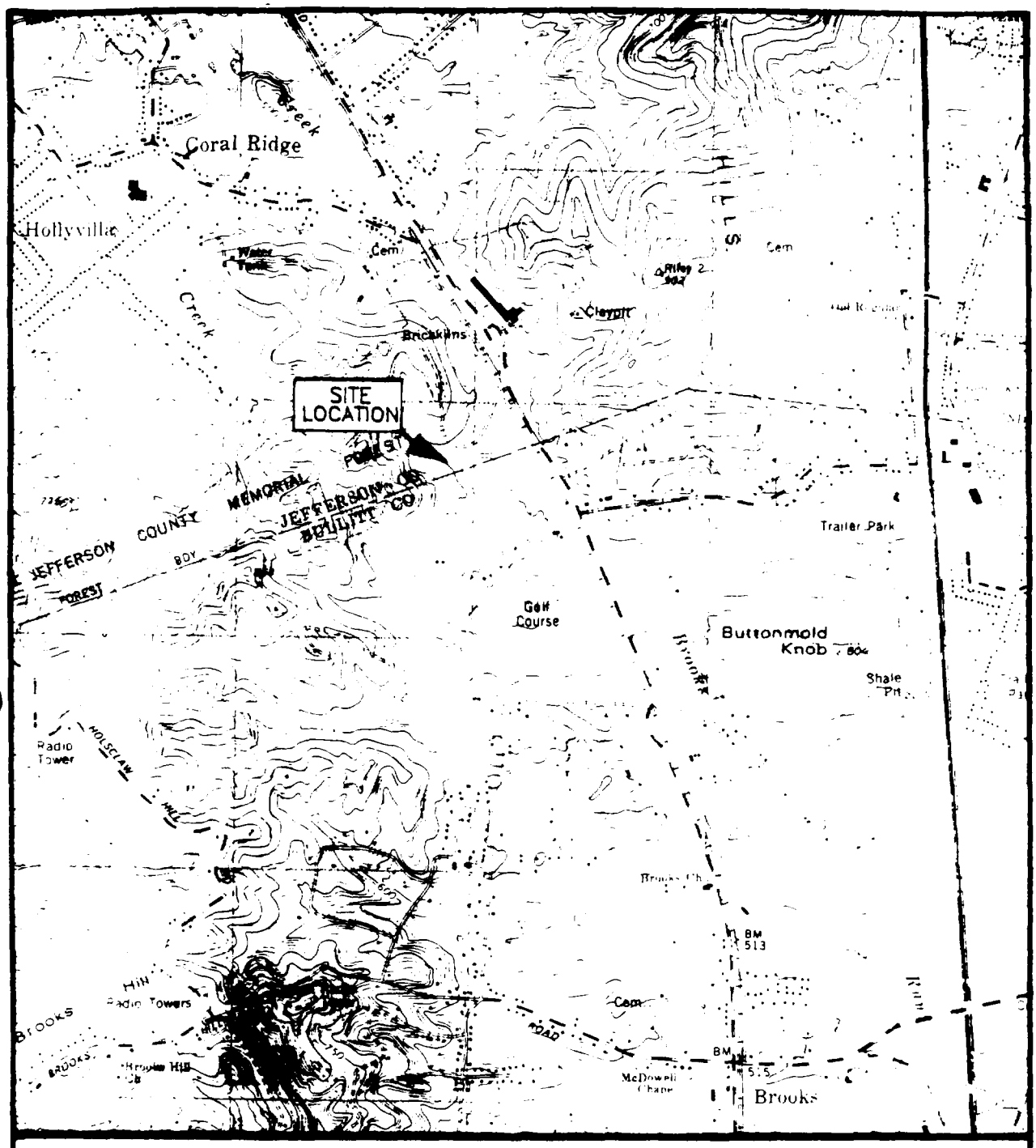


Figure 2

U.S.G.S. Quadrangle Map: Brooks
TDD #04-9212-0012-4186
Jefferson Forest Drum Site
Brook, Bullitt County, Kentucky

EPA

FIGURE 3

Site Diagram

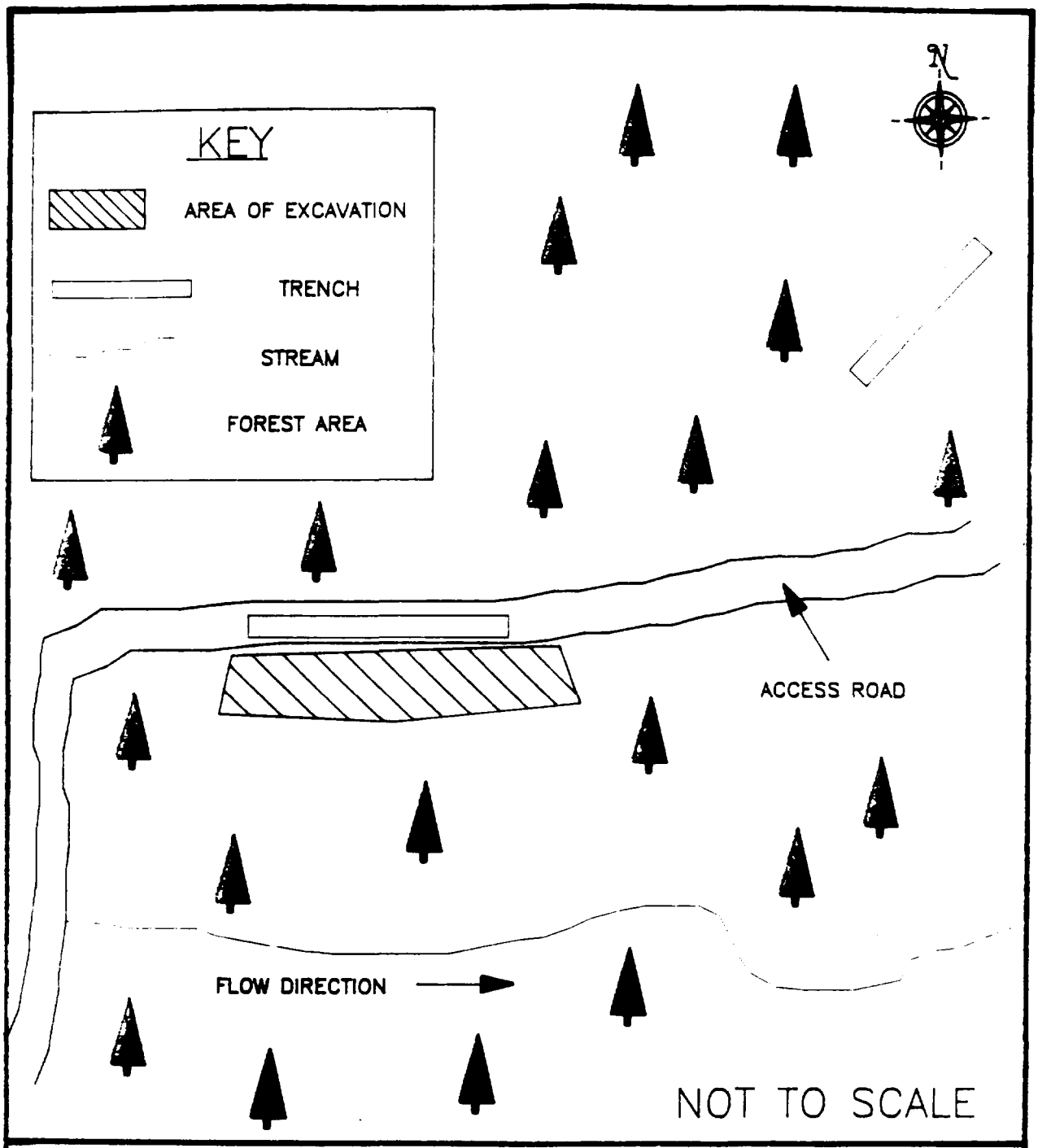


Figure 3: Site Map

TDD #04-9212-0012-4186
Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

EPA

ATTACHMENT A

Photographs

PHOTO NUMBER 2
OFFICIAL PHOTOGRAPH
ENVIRONMENTAL PROTECTION AGENCY

Subject: Area of drums

Location: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

Photographer: Manka
Date: 10 February 1993

Witness: Maybriar
Time: 0800

TDD Number: 04-9212-0012-4186

Location of Negatives: Louisville TAT Office

PHOTO NUMBER 3
OFFICIAL PHOTOGRAPH
ENVIRONMENTAL PROTECTION AGENCY

Subject: Suspected paint waste

Location: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

Photographer: Manka
Date: 10 February 1993

Witness: Maybriar
Time: 0800

TDD Number: 04-9212-0012-4186

Location of Negatives: Louisville TAT Office

PHOTO NUMBER 4
OFFICIAL PHOTOGRAPH
ENVIRONMENTAL PROTECTION AGENCY

Subject: Excavation of hillside

Location: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

Photographer: Manka
Date: 10 February 1993

Witness: Maybriar
Time: 1030

TDD Number: 04-9212-0012-4186

Location of Negatives: Louisville TAT Office

PHOTO NUMBER 5
OFFICIAL PHOTOGRAPH
ENVIRONMENTAL PROTECTION AGENCY

Subject: Hillside excavation and termination at native soil

Location: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

Photographer: Manka
Witness: Maybriar
Date: 10 February 1993
Time: 1100

TDD Number: 04-9212-0012-4186

Location of Negatives: Louisville TAT Office

PHOTO NUMBER 6
OFFICIAL PHOTOGRAPH
ENVIRONMENTAL PROTECTION AGENCY

Subject: Top-of-hill trench to native soil

Location: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

Photographer: Manka
Witness: Maybriar
Date: 10 February 1993
Time: 1430

TDD Number: 04-9212-0012-4186

Location of Negatives: Louisville TAT Office

PHOTO NUMBER 7
OFFICIAL PHOTOGRAPH
ENVIRONMENTAL PROTECTION AGENCY

Subject: Unidentified white powder

Location: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

Photographer: Manka
Date: 10 February 1993

Witness: Maybriar
Time: 1445

TDD Number: 04-9212-0012-4186

Location of Negatives: Louisville TAT Office

PHOTO NUMBER 8
OFFICIAL PHOTOGRAPH
ENVIRONMENTAL PROTECTION AGENCY

Subject: Second trench east-northeast of hillside

Location: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

Photographer: Manka
Witness: Maybriar
Date: 10 February 1993
Time: 1530

TDD Number: 04-9212-0012-4186

Location of Negatives: Louisville TAT Office

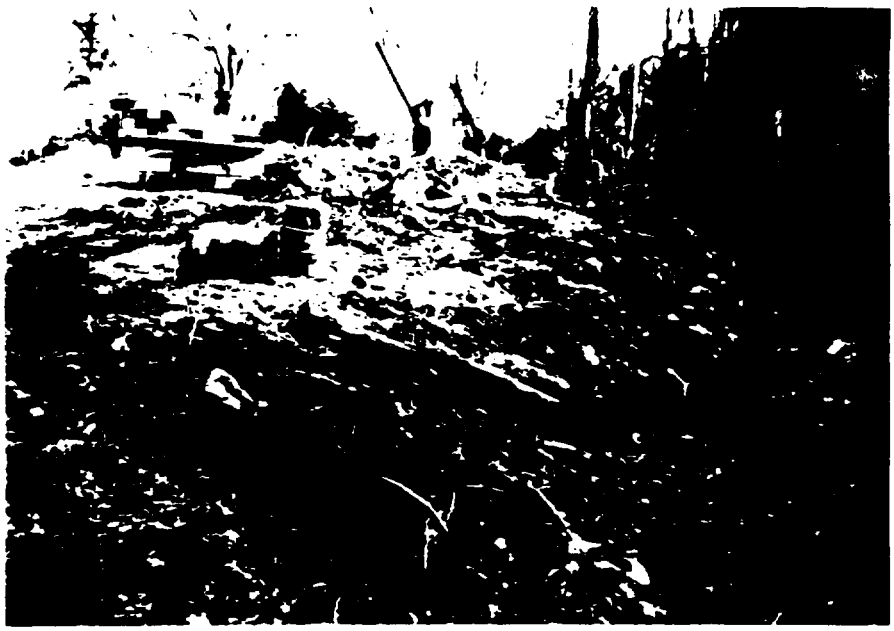


PHOTO NUMBER 9
OFFICIAL PHOTOGRAPH
ENVIRONMENTAL PROTECTION AGENCY

Subject: Crushing and grouping of empty drums

Location: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

Photographer: Manka
Date: 10 February 1993

Witness: Maybriar
Time: 1600

TDD Number: 04-9212-0012-4186

Location of Negatives: Louisville TAT Office

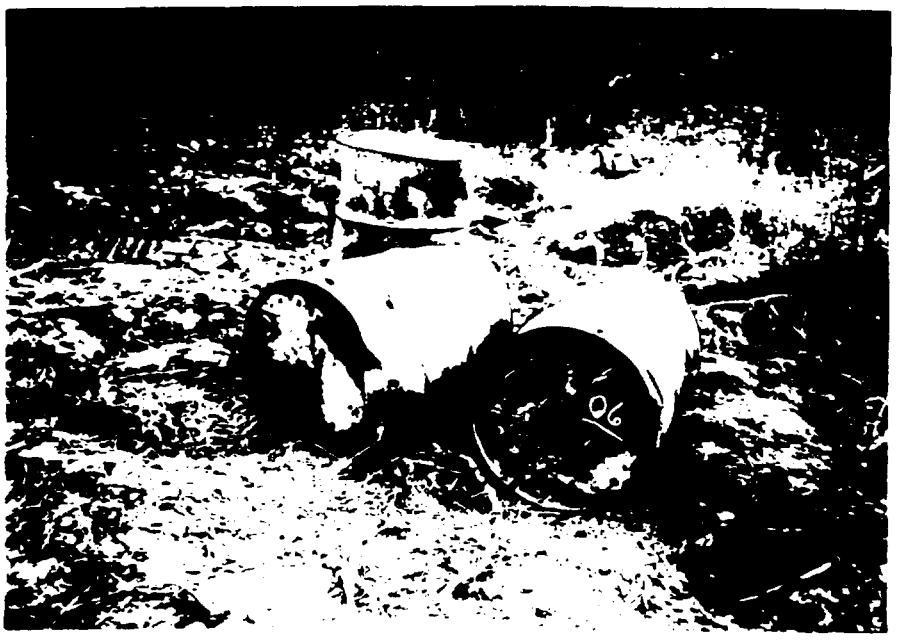


PHOTO NUMBER 10
OFFICIAL PHOTOGRAPH
ENVIRONMENTAL PROTECTION AGENCY

Subject: Drums which contained liquids and were sampled (Note sample numbers)

Location: Jefferson Forest Drum Site
Brooks, Bullitt County, Kentucky

Photographer: Manka
Witness: Maybriar
Date: 10 February 1993
Time: 1615

TDD Number: 04-9212-0012-4186

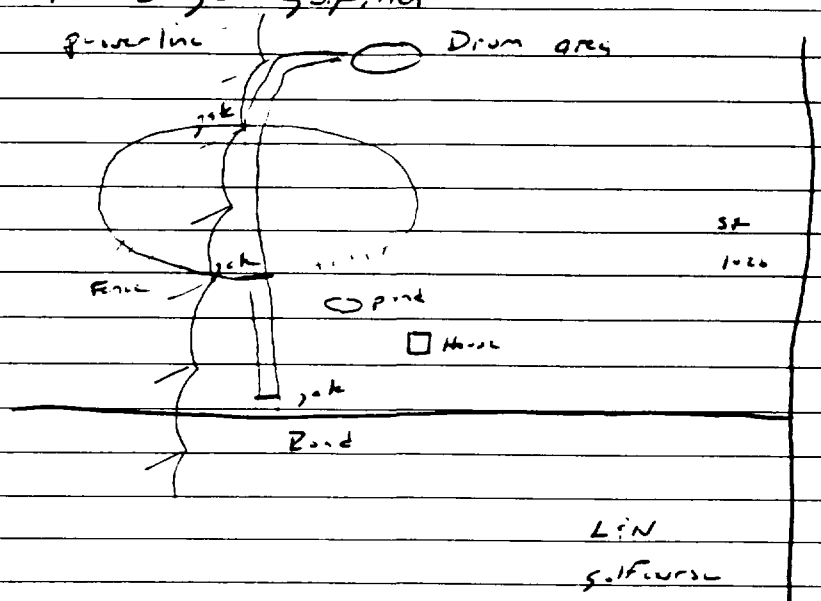
Location of Negatives: Louisville TAT Office

ATTACHMENT B

Log Notes

Jefferson County Forest
Drum Site

0800 TAT arrives on site and Heritage awaiting. Unlock the front gate and travel to rear of site to stage equipment



0815 TAT Maybrier given a tour of the site by TAT Marks. Observe numerous weathered drums partially buried in the hillside. Drums are rusted w/ bullet holes in them.

0835 Begin to clear brush with Komatsu PC 200 LC trackhoe rented from Rexco and brought to the site yesterday. Trees and brush

are removed and piled in east and west end of excavation area.

0915 Heritage crew sets up decon area and hot zone.

0945 OSC Gayle Scogan arrives onsite and meets Ron Moore w/ Heritage.

0955 Conduct safety meeting w/ Heritage

1005 Crew begins to don level B w/ egress lines. TAT Marks begins to dress out in Level B for air monitoring

1015 KDWM / Lajuanda Maybrier and ENC arrive onsite and meet OSC Scogan
Travel hillside and observe extent of visual drums

1105 TAT Maybrier and OSC dress out in Level B to air monitor and document ~~remove~~ act excavation activities
Air monitoring in several drums reveal 1 unit on HNu, Ø units and 45 units, Ø LEL and 20.8% O^2.
Background HNu 0 units, O^2 20.8 LEL 0%

1210 Stop exploratory excavation
All parties depart the site for lunch and will return at 1310 hrs OSC Dana Ann

Johnson arrives onsite at 1210 hrs

1300 All parties return to the site and Heritage continues with excavation.

1330 Two additional drums are unearthed containing lq. Staged on top of hill above excavation area

1405 Stop digging after completing initial exploratory excavation. Unearthed 3 drums (55 gallon) with some liquid and 20-25 empty drums (55 gallon).

15 Begin to dig an exploratory trench parallel to the hillside to a depth of 3-5 feet or until native soil is unearthed.

1435 No additional drums are found and trenches backfills with excavated soil

1450 Travel to open, barren area in field and continue exploratory digging in attempt to identify high magnetometer readings. A trench 4-5 feet deep is dug 30 feet long. No debris or waste is found. Backfill with excavated soil

1530 TAT prepares to collect six samples 1 sediment upgradient, 1 sediment downgradient, 1 waste(s), 3 waste (lq).

1520 JCF-01 upgradient sediment
1530 JCF-02 downgradient sediment
1545 JCF-03 white powder material
1555 JCF-04 Grey liq
1610 JCF-05 Bright green liq
1620 JCF-06 motor oil (?) liq
Note KDum personnel departed at 1455
~~Dr~~ TAT donned level B to collect the above mentioned samples. The samples will be shipped to:
Roy F. Weston, Inc Lab
212 Frank West Circle
Suite A
Stockton, CA 95206
Lori Cullen
209/983-1340

1630 Heritage segregates the empty drums and metal debris and crushes the material. The crushed material is placed on top of the hill in a pile. Additionally, any waste material is stored on top of hill in a pile.
1705 Heritage packs all PPE in garbage bag and will dispose of property
1715 The third drums are covered with visqueen and wrapped with caution tape

1730 All remaining parties depart the
S. k

Jon May

ATTACHMENT C

Table of Witnesses

TABLE OF WITNESSES

Gail Scogin, OSC
Dora Ann Johnson, OSC
U.S. Environmental Protection Agency
345 Courtland Street N.E.
Atlanta, Georgia 30365
(404)347-3431

Lajuanda Haight-Maybriar
Eric Liebenauer
Environmental Inspectors
Kentucky Department for Environmental Protection
Division of Waste Management
18 Reilly Road
Frankfort, Kentucky 40601
(502)564-6716

Ron Moore
Dennis Beavets
James Pollard
David Reynolds
Heritage Remediation/Engineering, Inc.
4925 Heller Avenue
Louisville, Kentucky 40218
(502)473-0638

Jon Maybriar
Matt Manka
Roy F. Weston, Inc.
Technical Assistance Team
10121 Production Court
Louisville, Kentucky, 40299
(502)491-0872

ATTACHMENT D

Safety Plan

WESTON MAJOR PROGRAMS DIVISION
HEALTH AND SAFETY PLAN
EMERGENCY RESPONSE / SITE INVESTIGATION

TDD No. 04-9212-0012-4186 **Site Name:** Jefferson Forest Drums

Site Address: Street No. _____

City Brooks

County/State Bullitt County, Kentucky

Site Contact / Phone No.: Lajuanda Haight - Maybriar (502) 564-6716

Directions to Site: (Att. Map) From Louisville, I-65 south to Brooks Road Exit (SR1526). Follow SR1526 west to intersection of SR1020. Turn right on SR1020. Follow approximately 2 miles past the L&N Golf Course on left. Turn left on gravel road past golf course. Enter site through security gate on the right.

Historical/Current Site Information:

The Kentucky Department for Environmental Protection discovered 40 drums partially buried on the outskirts of the A.L. Taylor NPL site

Incident Type:
- ( ) Air Release - _____
- ( ) Spill - _____
- ( ) Fire - _____
- (✓) HW Site - _____

Location Class : ( ) Industrial ( ) Commercial (✓) Urban/Residential ( ) Rural

USEPA Contact: Charlie Stevens **Date of Initial Site Activities:** 1/11/93

Original HASP: Yes ✓ **Modification Number:** _____

Lead TAT: Manka **Site Health & Safety Coordinator:** Manka

Response Activities/Duration (fill in as applicable)

Emergency Response:
- ( ) Perimeter Recon. _____
- ( ) Site Entry _____
- ( ) Visual Documentation: _____
- ( ) Multi-media Sampling: _____
- ( ) Decontamination: _____

Assessment:
- (✓) Perimeter Recon. 2 days
- (✓) Site Entry
- (✓) Visual Documentation:
- (✓) Multi-media Sampling:
- (✓) Decontamination:

Physical Safety Hazards to Personnel

( ) Heat (✓) Cold (✓) Precipitation ( ) Confined Space ( ) Terrain
(✓) Walking/Working Surfaces ( ) Fire & Explosion ( ) Oxygen Deficiency
( ) Underground Utilities ( ) Overhead Utilities ( ) Heavy Equipment
(✓) Unknowns in Drums, Tanks, Containers ( ) Ponds, Lagoons, Impoundments
( ) Rivers, Streams ( ) Pressurized Containers, Systems ( ) Noise
( ) Illumination ( ) Nonionizing Radiation ( ) Ionizing Radiation

Biological Hazards to Personnel

( ) Infectious/Medical/Hospital Waste ( ) Non-domesticated Animals ( ) Insects
(✓) Poisonous Plants/Vegetation ( ) Raw Sewage

Training Requirements

(✓) 40 Hour General Site Worker Course with three days supervised experience.
( ) 24 Hour Course for limited, specific tasks with one day supervised experience.
( ) 24 Hour Course for Level D Site with one day supervised experience.
(✓) 8 Hour Annual Refresher Health and Safety Training.
(✓) 8 Hour Management/Supervisor Training in addition to basic training course.
( ) Site Specific Health and Safety Training.
( ) Pre-entry training for emergency response skilled support personnel.

Medical Surveillance Requirements

(✓) Baseline initial physical examination with physician certification.
(✓) Annual medical examination with physician certification.
( ) Site Specific medical monitoring protocol (Radiation, Pesticide, PCB, Metals).
( ) Asbestos Worker medical protocol.
( ) Exempt from medical surveillance:_____.
(✓) Examination required in event of chemical exposure or trauma.

Chemical Hazards To Personnel

Chemical Contaminant	Unknown

PEL		ppm or mg/m3
TLV		ppm or mg/m3
IDLH		ppm or mg/m3
Carcinogen		Yes
		No
Physical Form		Solid
		Liquid
		Gas
Color		
Odor		
Flashpoint		Degrees F or C
Flammable Limits		% UEL
		% LEL
Route of Exposure		Inhalation
		Skin Absorption
		Eye / Skin Contact
		Ingestion

Vapor Pressure	mm/Hg
Vapor Density	(Air = 1)
Specific Gravity	(Water = 1)
Solubility	
Incompatible Materials	
Ion Potential	eV

Instruments for Detection		
		PID w/ Probe
		FID
		CGI
		Rad meter
		pH meter
		Detector Tube
		RAM / Mini-RAM
		Other:

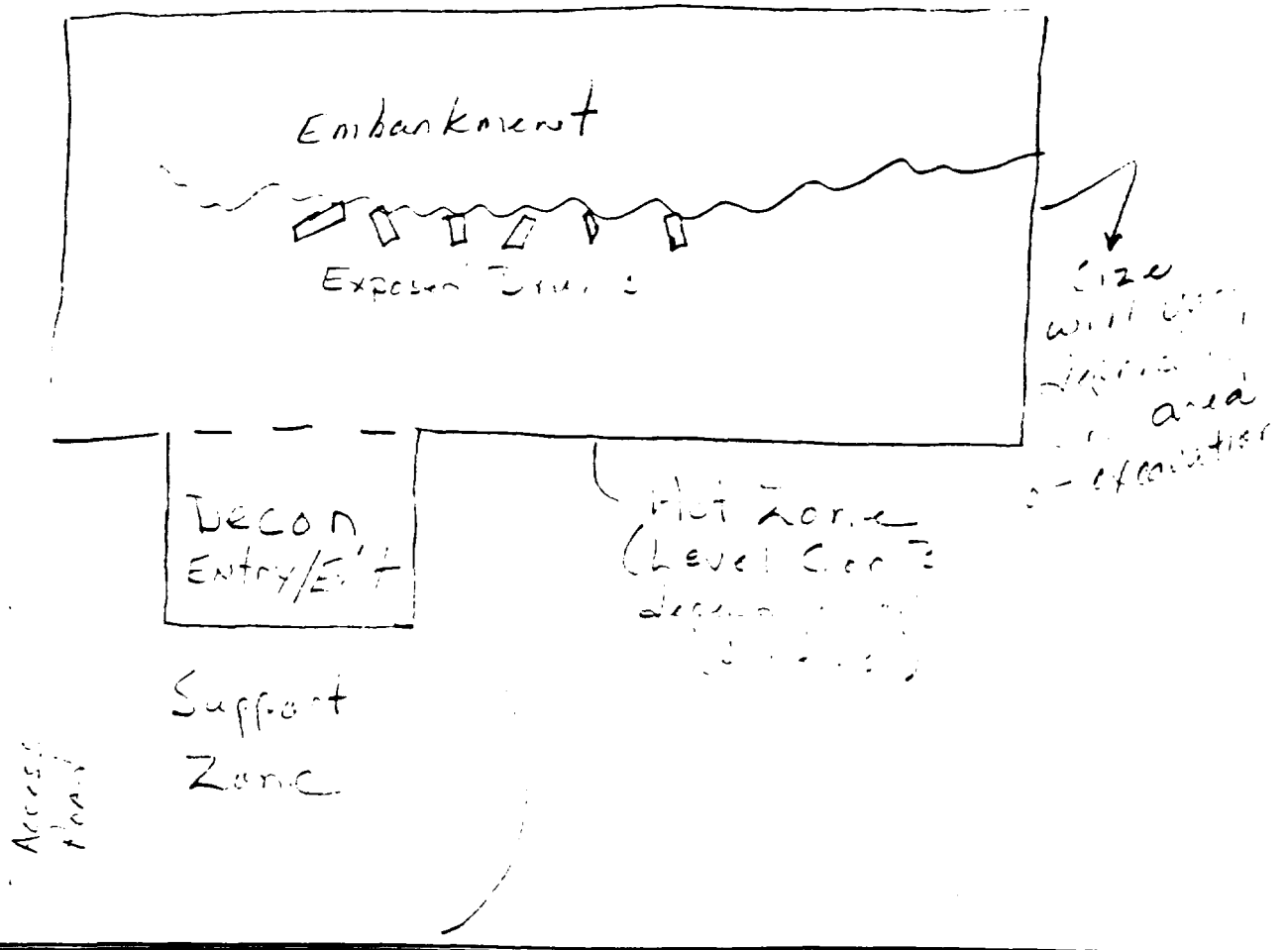
Symptoms of Acute Exposure		
		Confusion
		Convulsions
		Dizziness
		Drowsiness
		Giddiness
		Headache
		Irritation to eyes, nose or throat
		Lightheadedness
		Nausea
		Respiratory Problems
		Seizure
		Sweating (excessive)
		Vision Disturbance
		Weakness
		Other

First Aid Treatment		
		Irrigate Eyes w/ Water for 15 minutes
		Flush Skin w/ Water for 15 minutes
		Remove Contaminated Clothing
		Get Medical Attention
		Move to Fresh Air
		Provide Respiratory Support
		Other

Data Source		
		CHRIS
		NIOSH
		Sax
		HSDB
		Other:

Site Control Measures

Site Map with work zones:



Decontamination Procedures

(✓) Wet Decontamination - using: alconox + water
( ) Dry Decontamination

Description of Site Specific Decontamination Plan: All sampling equipment will be cleaned with soap + water, rinsed with deionized water and a final rinse with pesticide grade acetone. All PPE will be contained in proper receptacles with storage on-site until disposal has been arranged.

Adequacy of decontamination determined by: Site Health & Safety Officer

ersonal Protective Equipment

TAS TO BE PERFORMED/AIR MONITORING REQUIRED	ANTICIPATED LEVEL OF PROTECTION	TYPE OF CHEMICAL PROTECTIVE COVERALL	INNER GLOVE OUTER GLOVE BOOT COVER	TYPE OF APR CARTRIDGE OR CANISTER
Drum excavation and removal *	B	Saranex	nitrile gloves latex gloves PVC boots	SCBA
Perimeter monitoring during excavation	B	Saranex	latex gloves nitrile gloves PVC boots	SCBA
Drum Sampling	B	Saranex	latex nitrile PVC	SCBA
* See attached	regulations for	excavations		

requency and Types of Air Monitoring: (✓) Continuous ( ) Routine -_____ ( ) Periodic - _____

DIRECT READING INSTRUMENTS	COMBUSTIBLE GAS/OXYGEN METER (1)	RADIATION SURVEY METER/PROBE (2)	PHOTOIONIZATION DETECTOR/PROBE (3)	FLAME IONIZATION DETECTOR (4)	CHEM. DETECTOR TUBE (5)
ID NUMBER	637959	668842	637960 637961	668827	686682
CAL. DATE	12/29/92 *	12/29/92	12/23/92	12/29/92	12/29/92
TAT MEMBER	Manka	Manka	Keyes	Manka	Manka
ACT. N LEVEL	≥ 20%LEL - ≤19.5%, ≥23% O_2 - LEAVE	3X BACKGRND - CAUTION; 1 MR/HR-LEAVE	UNKNOWNS 0-5 UNITS:"C" 5-500:"B"	UNKNOWNS 0-5 UNITS:"C" 5-500:"B"	PEL/TLV COMPARE W/PF

* [illegible]

Emergency Phone Numbers

Emergency Contact	Location	Phone Number	Notified
Hospital	Humana Hospital Southwest 9920 3rd Street Road	502/933-8100	
Ambulance	Bullitt County Ambulance Zoneton	502/955-7580	
Police	Bullitt County Sheriff Zoneton	502/955-7804	
Fire Dept.	Zoneton	502/955-8076	

Chemical Trauma Capability? (✓) Yes ( ) No If no, closest backup:_____ Phone:_____

Directions to Hospital (attach map) - Route verified by: MB Date: 12/30/92

From site, SR 1020 south to SR 1526 east. Follow SR 1526 to I-65. Follow I-65 north to Hwy 841 (Gene Snyder Freeway). Follow Hwy 841 to the Stonestreet exit. Turn right on Stonestreet. Follow to T, make right on 3rd Street Road, then immediately left onto Hospital Drive.

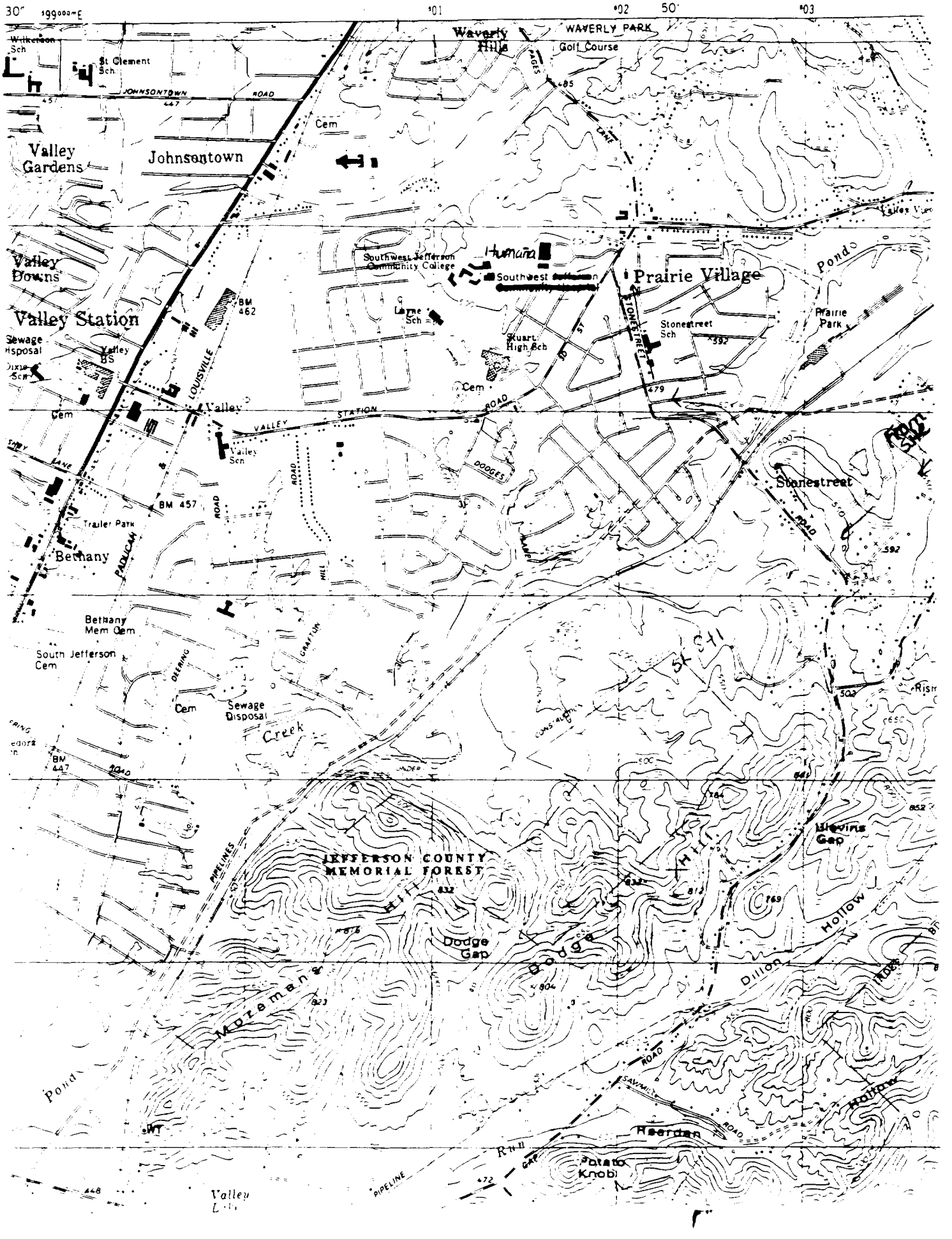
Additional Emergency Phone Contacts

Contact	Phone Number
WESTON 24 hr. Hotline	215-524-1925 215-524-1926
WESTON Medical Emergency Service	513-421-3063
Chemtrec	800-424-9300
ATSDR	404-639-0615
ATF (explosives information)	800-424-9555
National Response Center	800-424-8802
National Poison Control Center	800-942-5969

ASF prepared by: Leanna Smith Date: 12/10/92

re-Response/Entry Approval by: Ray Doyle (by phone) Date: 12/10/92

erbal Approval/Modification to Original HASP by:_____ Date: __/__/__


30"
199000mE
01
02
50'
03
Wilkerson Sch
St Clement Sch
JOHNSONTOWN ROAD
Waverly Hills
WAVERLY PARK
Golf Course
Cem
Valley Gardens
Johnsontown
Valley Downs
Valley Station
Sewage Disposal
Valley BS
Dixie Sch
Southwest Jefferson Community College
Humana
Southwest Jefferson Community College
Prairie Village
Pond
Prairie Park
Stonestreet Sch
Kuart High Sch
Cem
BM 462
LOUISVILLE
Valley
VALLEY STATION ROAD
Valley Sch
Cem
BM 457
Trailer Park
Bethany
PADUCAH
Stonestreet
Bethany Mem Cem
South Jefferson Cem
Cem
Sewage Disposal
Creek
BM 447
JEFFERSON COUNTY MEMORIAL FOREST
Dodge Gap
Dodge
Mozeman
Pond
Dillon
Hollow
Hollow
Hogan Gap
Hogan
Potato Knob
PIPELINE
Valley

Physical Description of Site and Response Activities

Size of Site: .25 Acre Terrain hill (Forest) Weather Sunny 65°
Distance to Nearest: Residence >1 m School >1 m Hospital >1 m
Public Building .5 m Other _____
Evacuation: ( ) Yes (✓) No By Whom: _____
Nearest Waterway: Unnamed intermittent Stream Distance from Site: 30 yds

Condition	Observed	Potential	None	Comments/Observations
Surface Water Contamination		✓		Stream sediment sampled
Ground Water Contamination			✓	
Drinking Water Contamination			✓	
Air Release			✓	
Soil Contamination		✓		leaky drums discovered
Stressed Vegetation			✓	
Dead Animal Species			✓	

Actions Taken On-Site:

Perimeter Monitoring: (✓) Yes ( ) No
Site Entry by TAT: (✓) Yes ( ) No

Tasks Conducted	Level of Protection/Specific PPE Used
Air Monitoring	Level B / nitrile, latex gloves, PVC boots SCBA, Sirenex
Drum Sampling	" / "

Air Monitoring Summary Log

Date: 2 / 9 / 92

Data Collected by: [illegible]

Data be summarized by a "Range of readings,i.e.,- Low to High" and/or "Average" by location.

Station/Location	CGI/O_2 Meter	Radiation Meter	PID/Probe	FID/OVA	Detector Tube
Background [illegible]	[illegible]	50 / .01 [illegible]	0	Not used	[illegible]
[illegible]	Bkrd [illegible]	Bkrd [illegible]	Bkrd [illegible]		
[illegible]	Bkrd [illegible]	Bkrd [illegible]	Bkrd [illegible]		
[illegible]	Bkrd	Bkrd	Bkrd		

Summary/Comments: _____

Hazardous Waste Site and Environmental Sampling Activities

Off Site: ( ) Yes (✓) No
On Site: (✓) Yes ( ) No

Describe types of samples and methods used to obtain samples: Product samples were collected out of the drums. Since product quantity was low, the drums were tipped and the product allowed to pour into sample container through bung hole or other opening. Work done in level B.

Was Laboratory notified of Potential Hazard Level Of Samples? (✓) Yes ( ) No

Note: The nature of the work assignment may require the use of the following procedures/programs which will be included as Attachments to this HASP as applicable: Emergency Response Plan, Confined Space Entry Procedures, Spill Containment Program.

Disclaimer: This Health and Safety Plan (HASP) was prepared for work to be conducted under the Technical Assistance Team (TAT) Contract 68-WO-0036 for Zone I. Use of this HASP by WESTON and its subcontractors is intended to fulfill the OSHA requirements found in 29 CFR 1910.120. Items not specifically covered in this HASP are included by reference to 29 CFR 1910 and 1926.

The signatures below indicate that the individuals have read and understood this Health and Safety Plan.

PRINTED NAME	SIGNATURE	AFFILIATION	DATE
David Reynolds	[illegible]	HR-E Operator	2-11-93
Dennis Brouets	[illegible]	HR/E Dr. Op	2-11-93
James Pollard	[illegible]	HR/E Rec Tech	2-11-93
Ron Moore	[illegible]	HR/E Supervisor	2-11-93
Jack Sheehan	[illegible]	U.S. EPA OSC	2/11/93

Final Submission of HASP by:	[illegible]	Date
Post Response Review by:		
Post Response Approval by:	[illegible]	3/23/93
TAT HSO Review by:		

COMMENTS/FOLLOWUP

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Requirements of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employers must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discrimination.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory penalties against employers of up to $1,000 for each serious violation and for optional penalties of up to $1,000 for each nonserious violation. Penalties of up to $1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to $10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of not more than $10,000, or by imprisonment for not more than six months, or by both. Conviction of an employer after a first conviction doubles these maximum penalties.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

Such voluntary action should initially focus on the identification and elimination of hazards that could cause death, injury, or illness to employees and supervisors. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

Consultation

Free consultative assistance, without citation or penalty, is available to employers, on request, through OSHA supported programs in most State departments of labor or health.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta, Georgia
Boston, Massachusetts
Chicago, Illinois
Dallas, Texas
Denver, Colorado
Kansas City, Missouri
New York, New York
Philadelphia, Pennsylvania
San Francisco, California
Seattle, Washington

Telephone numbers for these offices, and additional area office locations, are listed in the telephone directory under the United States Department of Labor in the United States Government listing.

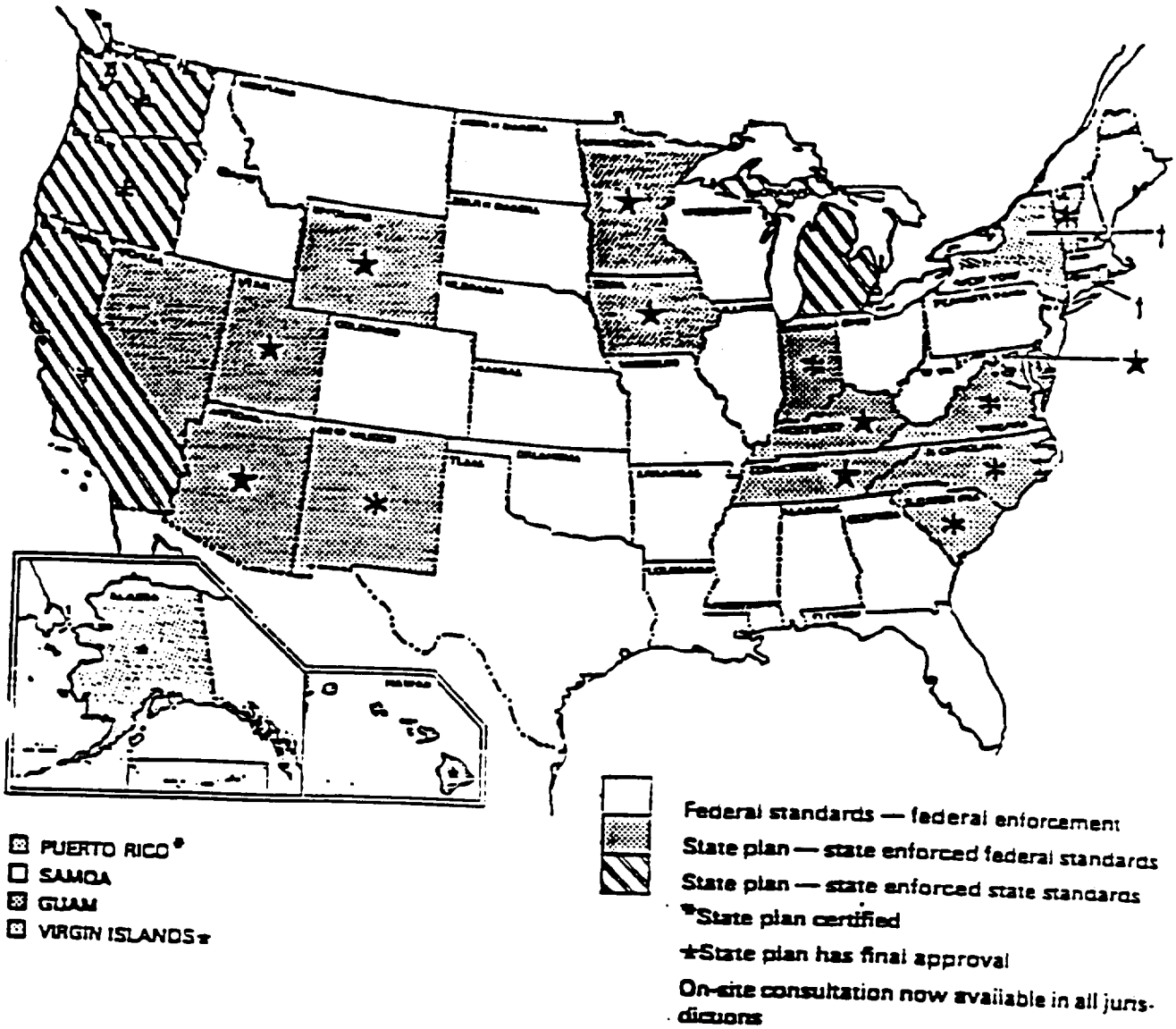
Washington, D.C.
1985
OSHA 2203

William E. Brock, Secretary of Labor

U.S. Department of Labor

Occupational Safety and Health Administration

STATE PLANS



FEDERAL OSHA AND STATE PLANS JURISDICTIONS

The above map represents the current status of jurisdictional areas for applicable OSHA or state regulations, inspections, and enforcement. At present, only four states (Washington, Oregon, California, and Michigan) have approved plans which differ significantly from federal standards.

All of the states are monitored by OSHA to determine state plan qualification. State plans must be judged "at least as effective as" the federal program in order to be approved. A state plan may receive OSHA approval by demonstrating it will meet all requirements within three years. After completing these steps and operating its program at a fully effective level for at least one year, federal enforcement will end in the areas covered by the state plan. OSHA then continues its monitoring to determine when the plan should be certified and when it should receive final approval.

†Connecticut and New York — state plan covers employees of state only; all other employees are under federal OSHA jurisdiction.

SECTION 23

EXCAVATIONS

23.A. GENERAL

23.A.01. The sides of all excavations in which employees are exposed to danger from moving ground shall be guarded by a shoring system, sloping of the ground, or other equivalent means. The minimum slope in any soil, with the exception of solid rock, shall be no less than 1/4 horizontal to 1 vertical.

23.A.02. The determination of angle of repose and design of supporting system shall be based on careful evaluation of pertinent factors such as: depth of cut, possible variation in water content of the material while the excavation is open; anticipated changes in materials from exposure to air, sun, water, or freezing; loading imposed by structures, equipment, overlaying material, or stored material; and vibration from equipment, blasting, or traffic.

23.A.03. Where a weak stratum is overlain by strata with a greater angle of repose, the angle of repose for the overlying strata shall be taken as no more than that of the supporting stratum.

23.A.04. Design of supporting system, i.e., piling, cribbing, shoring, etc., shall be based on calculation of forces and their direction with adequate consideration for surcharges, angle of internal friction of materials in the face, and other pertinent properties of the material to be retained in place. When tight sheeting or sheet piling is used, full loading due to ground water table shall be assumed unless prevented by weep holes, drains, or other means. Additional stringers, ties, and bracing shall be provided to allow for any necessary temporary removal of individual supports.

23.A.05. Except in hard rock, excavations below the level of the base of footing of any foundation or retaining wall shall not be permitted unless the wall is underpinned and all other precautions taken to insure the stability of the adjacent walls for the protection of the employees involved in excavation work or in the vicinity thereof. If the stability of adjoining buildings or walls is

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endangered by excavations, shoring, bracing, or underpinning designed by a qualified person shall be provided. Such shoring, bracing, or underpinning shall be inspected daily or more often, as conditions warrant, by the qualified person and the protection effectively maintained.

23.A.06. Diversion ditches, dikes, or other means shall be used to prevent surface water entering an excavation and to provide good drainage of the area adjacent to the excavation.

23.A.07. Excavated material shall be stored and retained at least 2 feet from the edge of the excavation and at a distance to prevent excessive loading on the face of the excavation.

23.A.08. Boulders, stumps, or other materials that may slide or roll into the excavation shall be removed or made safe.

23.A.09. Guardrails, fences, or barricades and warning lights or other illumination maintained from sunset to sunup, shall be placed at all excavations which are adjacent to paths, walkways, sidewalks, driveways, and other pedestrian or vehicle thoroughfares. Adequate physical protection shall be provided at all remotely located excavations. All wells, calyx holes, pits, shafts, etc., shall be barricaded or covered. Upon completion of exploration and similar operations, temporary wells, calyx holes, pits, shafts, etc., shall be backfilled immediately.

23.A.10. Walkways or bridges with guardrails shall be provided where people or equipment are required or permitted to cross over excavations.

23.A.11. Materials used for sheeting, sheet piling, cribbing, bracing, shoring, and underpinning shall be in good serviceable condition and of adequate dimensions. Timbers shall be sound and free of large or loose knots.

23.A.12. Side slopes and faces of all excavations shall be maintained in safe condition by sealing, ice removal, benching, barricading, rock bolting, wire mesh, or other means. Special attention shall be given to slopes which may be adversely affected by weather, moisture content, or vibration.

23.A.13. Precautions shall be taken in sloping or

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shoring the sides of excavations adjacent to a previously backfilled excavation or a fill, particularly when the separation is less than the depth of the excavation. Attention shall also be paid to joints and seams of material comprising a face and the slope of such seams and joints.

23.A.14. Support systems shall be planned and designed by a qualified person when an excavation is in excess of 20 feet in depth, adjacent to structures or improvements, or subject to vibration or ground water.

23.A.15. Prior to opening an excavation, underground installations (i.e., sewer, water, fuel, electric lines, etc.) shall be located and protected from damage or displacement. Utility companies shall be contacted to have them locate and mark actual locations.

23.A.16. Where unexploded munitions/military ordnance or hazardous materials may possibly be uncovered during excavation, job planning will require contact with local safety/health expertise.(See Appendix Y).

23.A.17. Where personnel are required to enter excavations over 4 feet in depth, sufficient stairs, ladders, or ramps shall be provided to require no more than 25 feet of lateral travel. When access to excavations in excess of 20 feet in depth is required, ramps, stairs, or mechanical personnel hoists shall be provided.

23.A.18. Where it is necessary to undercut the side of an excavation, overhanging material shall be safely supported.

23.A.19. Bracing, shoring, cribbing, and other supports shall be inspected daily and after every rainstorm or other hazard-increasing occurence by a competent person. Protection against slides and cave-ins shall be increased if necessary. If evidence of possible cave-ins or slides is apparent, all work in the excavation shall cease until the necessary precautions have been taken to safeguard the employees.

23.A.20. When tie rods are used to restrain the top of sheeting or other retaining system, the rods shall be anchored well back of the angle of repose.

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23.A.21. In locations where oxygen deficiency or gaseous conditions are known or suspected, air in the excavation shall be tested prior to the start of each shift or more often if directed by the designated authority. A log of all test results shall be maintained at the work site. Controls shall be in accordance with Sections 7 and 8.

23.A.22. Emergency rescue equipment such as breathing apparatus, safety harness and line, and basket stretcher shall be readily available where adverse atmospheric conditions are suspected or may develop in an excavation.

23.A.23. Where ramps are used, a minimum width of 4 feet for personnel and 12 feet for equipment shall be provided. Guardrails shall be provided on all personnel ramps. Curbs not less than 8 x 8-inch timbers or equivalent protection shall be provided on equipment ramps. Such ramps shall be designed and constructed in accordance with accepted engineering practice and 22.D.

23.A.24. When mobile equipment is utilized or allowed adjacent to excavations, substantial stop logs or barricades shall be installed.

23.A.25. Excavating or hoisting equipment shall not be allowed to raise, lower, or swing loads over personnel in the excavation without substantial overhead protection.

23.A.26. At least two means of exit shall be provided for personnel working in excavations. Where the width of the excavation exceeds 100 feet, two or more means of exit shall be provided on each side of the excavation.

23.A.27. Ground water shall be controlled. Freezing, pumping, drainage, and similar control measures shall be planned and directed by a competent engineer. Consideration shall be given to the existing moisture balances in surrounding soils and the effects on foundations and structures if it is disturbed. When continous operation of ground water control equipment is necessary, an emergency power source shall be provided.

23.B. TRENCH EXCAVATION

23.B.01. Banks more than 5 feet high shall be

shored, laid back to a stable slope, or provided with other equivalent protection where employees may be exposed to moving ground or cave-ins. Trenches less than 5 feet in depth also shall be protected when examination of the ground indicates hazardous ground movement may be expected. The safe angle of repose for soil conditions and bracing systems shall be determined by a qualified person.

23.B.02. Bracing or shoring of trenches shall be carried along with the excavation.

23.B.03. Cross braces or trench jacks shall be in true horizontal position, secured to prevent sliding, falling, or kick-outs.

23.B.04. Portable trench boxes, sliding trench boxes, or shields shall be designed, constructed, and maintained in a manner to provide protection equal to or greater than the sheathing and shoring required for the situation.

23.B.05. Ladders used as accessways shall extend from the bottom of the trench to not less than 3 feet above the surface. Lateral travel to an exit ladder shall not exceed 25 feet.

23.B.06. Backfilling and removal of trench supports should progress together from the bottom of the trench. Jacks or braces shall be released slowly and, in unstable soil, ropes shall be used to pull out the jacks or braces from above after personnel have cleared the trench.

23.B.07. Minimum size and spacing of timbers for shoring of trenches shall be in accordance with APPENDIX J.

23.B.08. Braces and diagonal shores in a wood shoring system shall not be subjected to compressive stress in excess of values given by the following formula:

$$S=1300-\frac{20L}{D}$$

Maximum ratio $\frac{L}{D}=50$

Where:

L = Length, unsupported, in inches.

D = Least side of the timber in inches.
S = Maximum allowable stress in pounds per square inch of cross section.

23.B.09. Aluminum hydraluic shoring shall be installed in accordance with the manufacturer's recommendations and requirements of 23.A.04.

23.C. EXCAVATION OF SMALL DIAMETER SHAFTS

23.C.01. Calyx holes, caisson footings, and other small diameter shafts, which persons are required to enter, shall be provided with a steel casing of sufficient strength to withstand shifting of the surrounding earth. Casing shall be provided the full depth of the overburden and shall extend at least 5 feet into solid rock, where such conditions exist.

23.C.02. The steel casing shall extend at least 1 foot above ground level and be equipped with a cover that can be locked. This cover shall be in place whenever no work is being performed in the excavation and until the excavation is backfilled to ground level.

23.C.03. Prior to working in a shaft, air at the bottom of the shaft shall be tested for oxygen deficiency and harmful contaminants. No work shall be done in the shaft until the air is safe for breathing.

23.C.04. Mechanical ventilation shall be used to change the air in shafts. Compressed air from an untested source shall not be used.

23.C.05. Hoisting of persons shall be done only with equipment meeting applicable requirements contained in section 22.G.

23.C.06. An inclosed covered metal cage shall be used to raise and lower persons in the shaft. The cage shall be designed with a safety factor of 4 and shall be load tested prior to use. The exterior of the cage shall be free of projections or sharp corners. Only closed shackles shall be used in the cage rigging.

23.C.07. If the cage is equipped with a door, a positive locking device shall be installed to prevent the door from opening accidentally while the cage is being lowered or raised.

23.C.08. The rigging and cage shall be checked at the start of each shift by lowering the empty cage to the bottom of the shaft and hoisting it to the surface.

23.C.09 If the work or an emergency prohibits the use of a cage, persons may be raised and lowered in the shaft in the muck bucket or a boatswain's chair. Persons hoisted in this manner shall wear a parachute-type harness with an independent safety line attached. "Riding the Hook" shall not be permitted.

23.C.10. A tender shall be stationed at the shaft entrance whenever personnel are in the shaft. He/she will be assigned no other duties.

23.C.11. A communication or signal system shall be provided and used.

23.C.12. Procedures for rescuing personnel who might be injured or incapacitated while in the shaft shall be written and posted at the job site. These procedures shall include hoisting procedures to be used in the event the cage and the cage hoisting device is inoperative.

23.C.13. No employee shall be permitted to enter an unsupported auger-type excavation in unstable material for any purpose. Necessary clean-out in such cases shall be accomplished without entry.

23.C.14. All wells or shafts over 5 feet in depth shall be retained with lagging, piling or casing.

23.C.15. In shafts, the employer shall inspect the walls, ladders, timbers, blocking, and wedges of the last set to determine if they have loosened following blasting operations. Where found unsafe, corrections shall be made before shift operations are started.

23.C.16. Safety belts shall be worn or skips and platforms used in shafts by crews when the skip or cage does not occlude the opening to within 1 foot of the sides of the shaft, unless guardrails or cages are provided.

23.D. EXCAVATION WITH COFFERDAMS

23.D.01. If overtopping of the cofferdams by high water is possible, design shall include provisions

for controlled flooding of the work area.

23.D.02. Where personnel or equipment are required or permitted on cofferdams, walkways, bridges, or ramps, standard railings or equilvalent protection shall be provided.

23.D.03. At least two ladders, walkways, ramps, roads or other means of rapid exit shall be provided for personnel and equipment working on cofferdams.

23.D.04. A plan including warning signal for excavation of personnel and equipment in case of emergency and for controlled flooding shall be developed and posted.

23.D.05. Cofferdams located close to navigable shipping channels shall be protected from vessels in transit, where possible.

23.E. CAISSONS

23.E.01. Whenever, in caisson work in which compressed air is used, and the working chamber is less than 11 feet in length, and when such caissons are at any time suspended or hung while work is in progress so that the bottom of the excavation is more than 9 feet below the deck of the working chamber, a shield shall be erected therein for the protection of the employees.

23.E.02. Shafts shall be subjected to a hydrostatic test, at which pressure they shall be tight. The shaft shall be stamped on the outside shell about 12 inches from each flange to show the safe working pressure.

23.E.03. Whenever a shaft is used, it shall be provided, where space permits, with a safe, proper, and suitable staircase for its entire length, including landing platforms (not more than 20 feet apart). Where this is impractical, ladders not more than 20 feet high shall be installed with each section offset from adjacent sections and a guarded landing provided at each offset.

23.E.04. All caissons having a diameter or side greater than 10 feet shall be provided with a man lock and shaft for the exclusive use of employees.

23.E.05. In addition to the gauge in the locks,

an accurate gauge shall be maintained on the outer and inner side of each bulkhead. These gauges shall be accessible at all times and kept in accurate working order.

23.E.06. See 05.C. for employee physical qualifications.

23.E.07. See 24.F. for compressed air requirements.

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FEDERAL REGISTER

PART 1926.650 (AMENDED)

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PART 1926—[AMENDED]

Subpart M—[Amended]

1. By revising the authority citation for subpart M of part 1926 to read as follows:

Authority: Sec. 107, Contract Work Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable, and 29 CFR part 1911.

2. By revising subpart P of part 1926 to read as follows:

Subpart P—Excavations

Sec.
1926.650 Scope, application, and definitions applicable to this subpart.
1926.651 General requirements.
1926.652 Requirements for protective systems.

Appendix A to Subpart P—Soil Classification

Appendix B to Subpart P—Sloping and Benching

Appendix C to Subpart P—Timber Shoring for Trenches

Appendix D to Subpart P—Aluminum Hydraulic Shoring for Trenches

Appendix E to Subpart P—Alternatives to Timber Shoring

Appendix F to Subpart P—Selection of Protective Systems

Subpart P—Excavations

Authority: Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), or 9–83 (48 FR 35736), as applicable, and 29 CFR part 1911.

§ 1926.650 Scope, application, and definitions applicable to this subpart.

(a) *Scope and application.* This subpart applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.

(b) *Definitions applicable to this subpart.*

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum Hydraulic Shoring means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Bell-bottom pier hole means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Benching (Benching system) means a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Cave-in means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or walers.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Faces or *sides* means the vertical or inclined earth surfaces formed as a result of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Kickout means the accidental release or failure of a cross brace.

Protective system means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Ramp means an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Registered Professional Engineer means a person who is registere professional engineer in the stat the work is to be performed. Howeve professional engineer, registered in a state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated da to be used in interstate commerce.

Sheeting means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can either premanufactured or job-built in accordance with § 1926.652 (c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" "trench shields."

Shoring (Shoring system) means a structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavatio and which is designed to preven e ins.

Sides. See "Faces."

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides o an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by anoth protective system that has been designed by a registered professional engineer.

Structural ramp means a ramp built steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

Support system means a structure such as underpinning, bracing, or shoring, which provides support adjacent structure, underground

installation, or the sides of an excavation.

Tabulated data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box. See "Shield."

Trench shield. See "Shield."

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

§ 1926.651 General requirements.

(a) *Surface encumbrances.* All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.

(b) *Underground installations.* (1) The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.

(2) Utility companies or owners shall be contacted within established or customary local response times, advised of the proposed work, and asked to establish the location of the utility underground installations prior to the start of actual excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used.

(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.

(4) While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.

(c) *Access and egress*—(1) *Structural ramps.* (i) Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.

(ii) Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.

(iii) Structural members used for ramps and runways shall be of uniform thickness.

(iv) Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway or shall be attached in a manner to prevent tripping.

(v) Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.

(2) *Means of egress from trench excavations.* A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.

(d) *Exposure to vehicular traffic.* Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

(e) *Exposure to falling loads.* No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with § 1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations.

(f) *Warning system for mobile equipment.* When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

(g) *Hazardous atmospheres*—(1) *Testing and controls.* In addition to the requirements set forth in subparts D and E of this part (29 CFR 1926.50–1926.107) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:

(i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.

(ii) Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with subparts D and E of this part respectively.

(iii) Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.

(iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

(2) *Emergency rescue equipment.* (i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

(ii) Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a life-line securely attached to it. The lifeline shall be separate from any line used to handle materials, and shall be individually

attended at all times while the employee wearing the lifeline is in the excavation.

(h) *Protection from hazards associated with water accumulation.* (1) Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline.

(2) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.

(3) If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with paragraphs (h)(1) and (h)(2) of this section.

(i) *Stability of adjacent structures.* (1) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.

(2) Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be permitted except when:

(i) A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or

(ii) The excavation is in stable rock; or

(iii) A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or

(iv) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

(3) Sidewalks, pavements, and appurtenant structure shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

(j) *Protection of employees from loose rock or soil.* (1) Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.

(2) Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least 2 feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

(k) *Inspections.* (1) Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

(2) Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

(l) *Fall protection.* (1) Where employees or equipment are required or permitted to cross over excavations, walkways or bridges with standard guardrails shall be provided.

(2) Adequate barrier physical protection shall be provided at all remotely located excavations. All wells, pits, shafts, etc., shall be barricaded or covered. Upon completion of exploration and similar operations, temporary wells, pits, shafts, etc., shall be backfilled.

§ 1926.652 Requirements for protective systems.

(a) *Protection of employees in excavations.* (1) Each employee in excavation shall be protected f ing by an adequate protective syste designed in accordance with parag (b) or (c) of this section except whe

(i) Excavations are made entirely stable rock; or

(ii) Excavations are less than 5 fe (1.52m) in depth and examination o ground by a competent person prov no indication of a potential cave-in.

(2) Protective systems shall have capacity to resist without failure all loads that are intended or could reasonably be expected to be applie transmitted to the system.

(b) *Design of sloping and benchin systems.* The slopes and configurati of sloping and benching systems sha be selected and constructed by the employer or his designee and shall b accordance with the requirements o paragraph (b)(1); or, in the alternativ paragraph (b)(2); or, in the alternativ paragraph (b)(3); or, in the alternativ paragraph (b)(4), as follows:

(1) *Option (1)—Allowable configurations and slopes.* (i) Excavations shall be sloped at an an not steeper than one and one-half horizontal to one vertical (34 degrees measured from the horizontal), u the employer uses one of the othe options listed below.

(ii) Slopes specified in paragraph (b)(1)(i) of this section, shall be excavated to form configurations tha are in accordance with the slopes sec for Type C soil in Appendix B to this subpart.

(2) *Option (2)—Determination of slopes and configurations using Appendices A and B.* Maximum allowable slopes, and allowable configurations for sloping and benchi systems, shall be determined in accordance with the conditions and requirements set forth in appendices A and B to this subpart.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of sloping benching systems shall be selected fro and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and shall include all of th following:

(A) Identification of the parameters that affect the selection of a sloping or benching system drawn from such dat

(B) Identification of the limits of use the data, to include the magnitude and configuration of slopes determine safe;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) The magnitude of the slopes that were determined to be safe for the particular project;

(B) The configurations that were determined to be safe for the particular project; and

(C) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be at the jobsite, but a copy shall be made available to the Secretary upon request.

(c) *Design of support systems, shield systems, and other protective systems.* Designs of support systems, shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:

(1) *Option (1)—Designs using appendices A, C and D.* Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D.

(2) *Option (2)—Designs Using Manufacturer's Tabulated Data.* (i) Design of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

(ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed after the manufacturer issues specific written approval.

(iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall be made available to the Secretary upon request.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and include all of the following:

(A) Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

(B) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.

(d) *Materials and equipment.* (1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

(2) Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

(3) When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment shall be removed from service, and shall be evaluated and approved by a registered professional engineer before being returned to service.

(e) *Installation and removal of support.*—(1) *General.* (i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.

(ii) Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

(v) Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling shall progress together with the removal of support systems from excavations.

(2) *Additional requirements for support systems for trench excavations.* (i) Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

(ii) Installation of a support system shall be closely coordinated with the excavation of trenches.

(f) *Sloping and benching systems.* Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.

(g) *Shield systems*—(1) *General.* (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

(2) *Additional requirement for shield systems used in trench excavations.* Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

Appendix A to Subpart P

Soil Classification

(a) *Scope and application*—(1) *Scope.* This appendix describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. The appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils.

(2) *Application.* This appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in § 1926.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1926, and when aluminum hydraulic shoring is designed in accordance with appendix D. This Appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in § 1926.652(c), and the use of the data is indicated on the use of the soil classification as set forth in this appendix.

(b) *Definitions.* The definitions and examples given below are based on, in whole or in part, the following: American Society for Testing Materials (ASTM) Standards D653–85 and D2488: The Unified Soils Classification System, The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report BSS–127.

Cemented soil means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

Cohesive soil means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical sideslopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

Dry soil means soil that does not exhibit visible signs of moisture content.

Fissured means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

Granular soil means gravel, sand, or silt (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easy when dry.

Layered system means two or more distinctly different soil or rock types arranged in layers. Microseismic seams or weakened planes in rock or shale are considered layered.

Moist soil means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

Plastic means a property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

Saturated soil means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or shear vane.

Soil classification system means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

Stable rock means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Submerged soil means soil which is underwater or is free seeping.

Type A means cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

(i) The soil is fissured; or

(ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or

(iii) The soil has been previously disturbed; or

(iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or

(v) The material is subject to other factors that would require it to be classified as a less stable material.

Type B means:

(i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or

(ii) Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.

(iii) Previously disturbed soils except those which would otherwise be classed as Type C soil.

(iv) Soil that meets the unconfined compressive strength or cohesion requirements for Type A, but is fissured or subject to vibration; or

(v) Dry rock that is not stable; or

(vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified Type B.

Type C means:

(i) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or

(ii) Granular soils including gravel, sand, and loamy sand; or

(iii) Submerged soil or soil from which water is freely seeping; or

(iv) Submerged rock that is not stable, or

(v) Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

Unconfined compressive strength means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

Wet soil means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose these cohesive properties when wet.

(c) *Requirements*—(1) *Classification of soil and rock deposits.* Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this appendix.

(2) *Basis of classification.* The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses

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shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification and testing such as those adopted by the America Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

(3) *Visual and manual analyses.* The visual and manual analyses, such as those noted as being acceptable in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(5) *Reclassification.* If, after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) *Acceptable visual and manual tests.*—(1) *Visual tests.* Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) *Manual tests.* Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil property.

(i) *Plasticity.* Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as ⅛-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of ⅛-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) *Dry strength.* If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488—"Standard Recommended Practice for Description of Soils (Visual—Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

(v) *Drying test.* The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as a unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

Appendix B to Subpart P

Sloping and Benching

(a) *Scope and application.* This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in § 1926.652(b)(2).

(b) *Definitions.*

Actual slope means the slope to which an excavation face is excavated.

Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and raveling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) *Requirements.*—(1) *Soil classification.* Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) *Actual slope.* (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least ¼ horizontal to one vertical (¼H:1V) less steep than the maximum allowable slope.

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with § 1926.651(i).

(4) *Configurations.* Configurations of sloping and benching systems shall be in accordance with Figure B-1.

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TABLE B-1

MAXIMUM ALLOWABLE SLOPES

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V) [1] FOR EXCAVATIONS LESS THAN 20 FEET DEEP [3]
STABLE ROCK	VERTICAL (90°)
TYPE A [2]	3/4 : 1 (53°)
TYPE B	1:1 (45°)
TYPE C	1½: 1 (34°)

NOTES:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).
3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

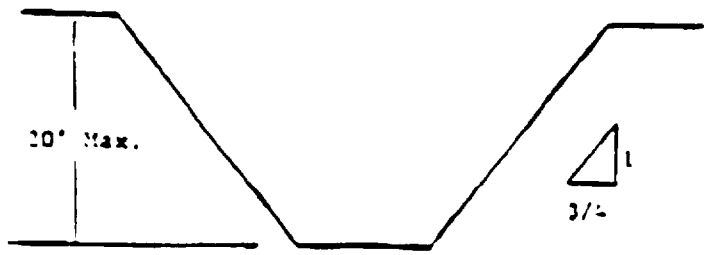
Figure B-1

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

B-1.1 Excavations made in Type A soil.

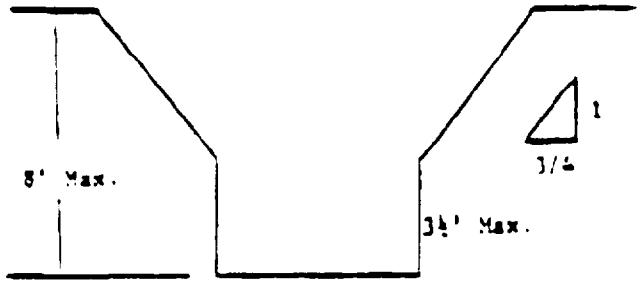
1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.



Simple Slope—General

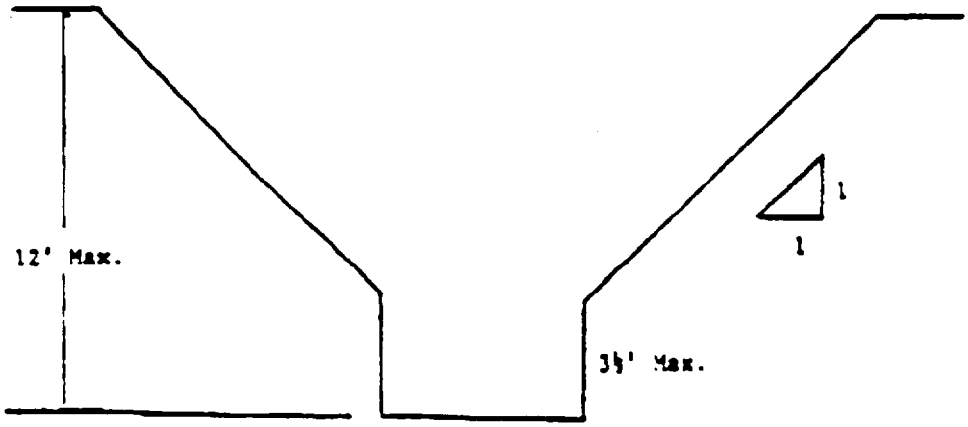
Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1.

SENT BY:WESTON REGION IV TAT ;12-27-96 ;12:01AM ; 4042822659→ 502 499 9019;#20



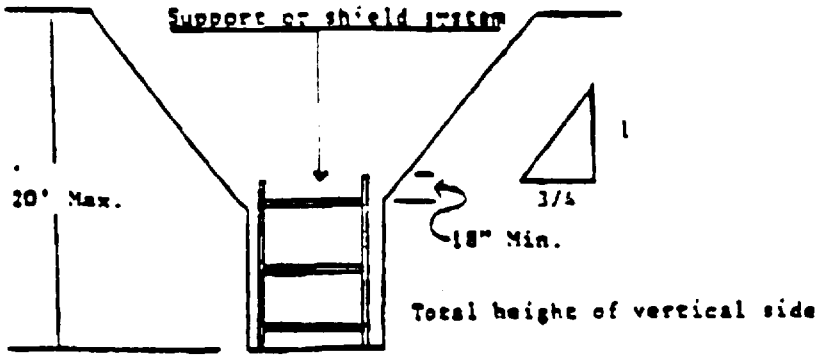
Unsupported Vertically Sided Lower Portion—Maximum 8 Feet in Depth

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



Unsupported Vertically Sided Lower Portion—Maximum 12 Feet in Depth

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾:1. The support or shield system must extend at least 18 inches above the top of the vertical side.



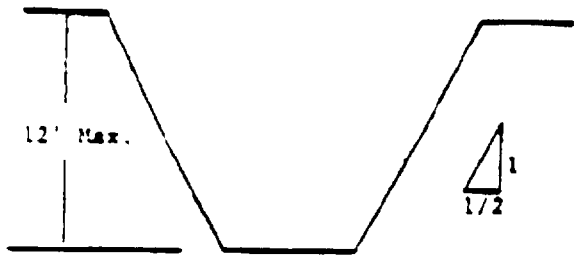
Supported or Shielded Vertically Sided Lower Portion

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options noted under § 1926.652(b).

B-2.2 Excavations Made in Type B Soil

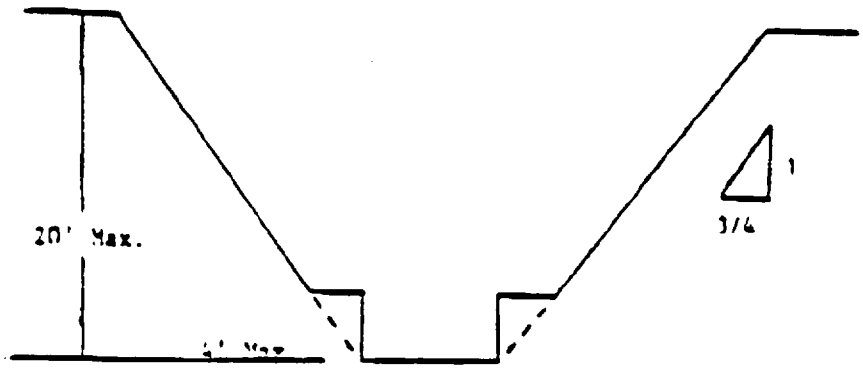
1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

SENT BY:REGION 10 TAT ;12-22-92 ;13:31PM ; 4043563689→ 502 499 9219;#21

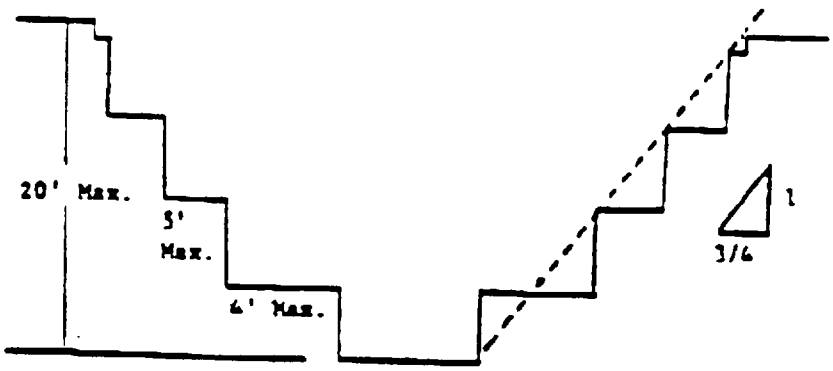


Simple Slope—Short Term

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of ¾ to 1 and maximum bench dimensions as follows:



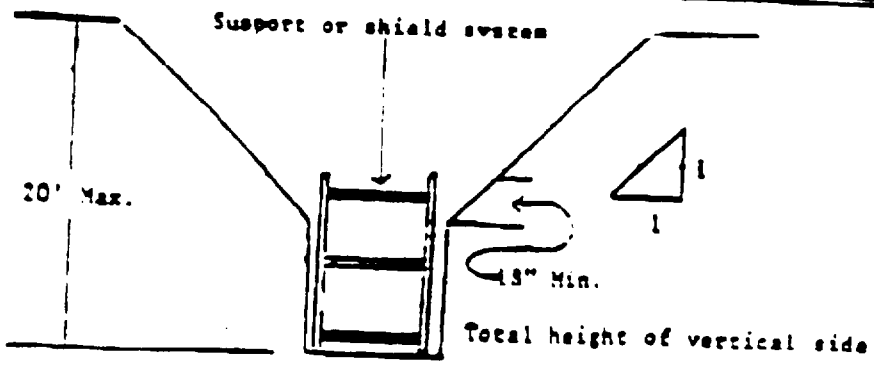
Simple Bench



Multiple Bench

3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.

SENT BY:KEYSTONE REGION IV TMT ;12-22-92 ;12:02PM ; 4042520659→ 502 499 5019;#22

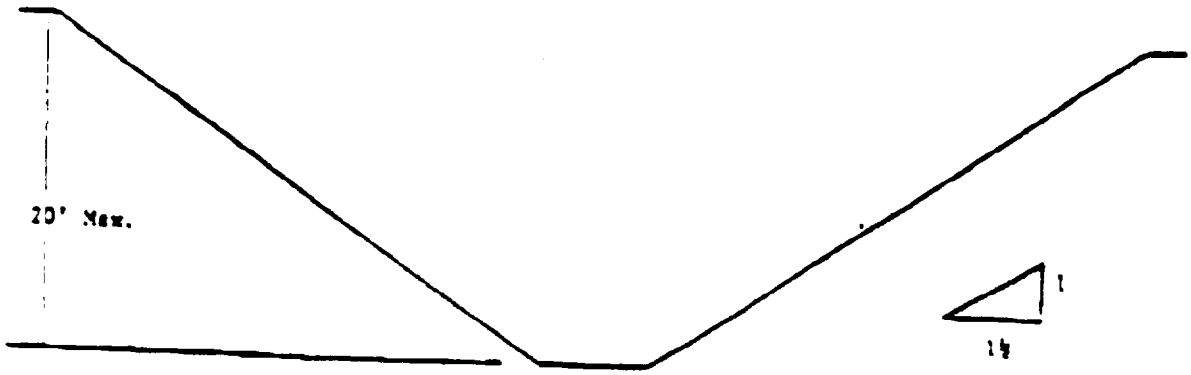


Vertically Sided Lower Portion

4. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

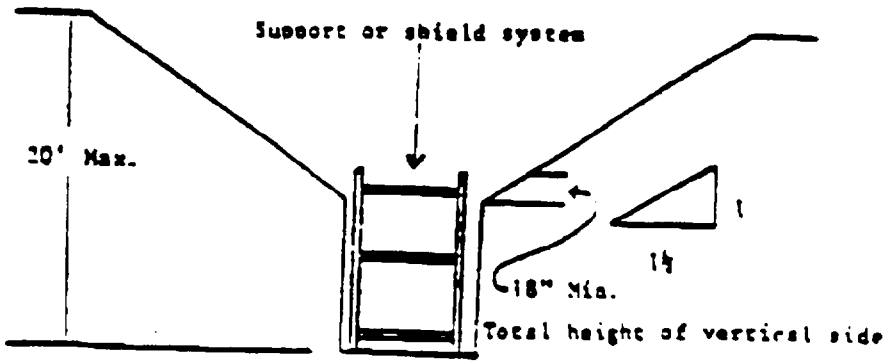
B-1.3 Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



Simple Slope

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.



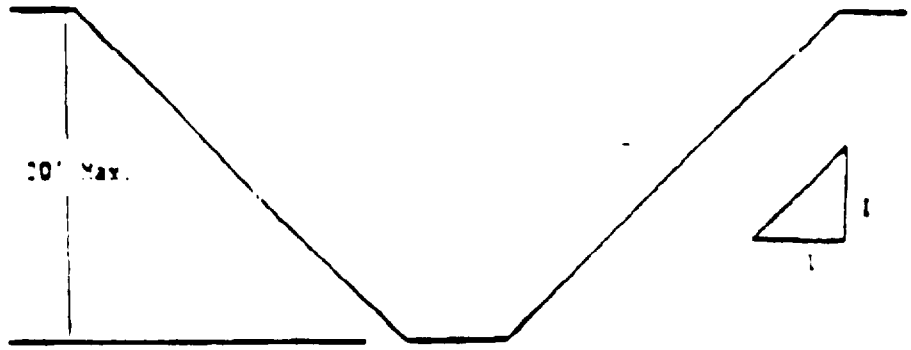
Vertical Sided Lower Portion

. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

B-1.4 Excavations Made in Layered Soils

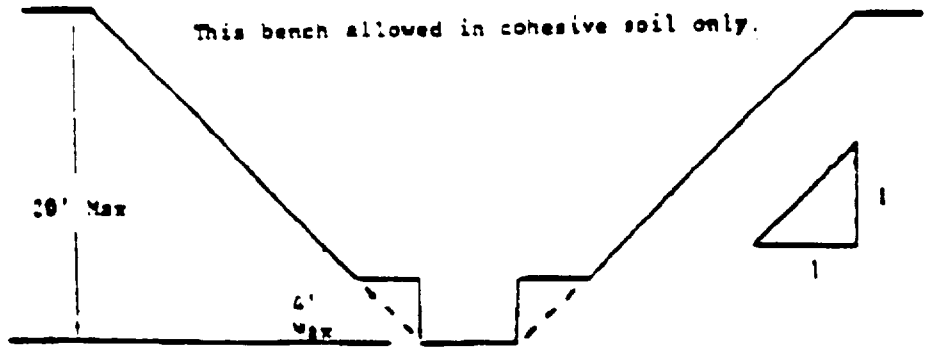
1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.

SENT BY:JUDICTON REGION IV TAT ;12-22-92 10:02AM ; 4043520659→ 502 499 9019;#23

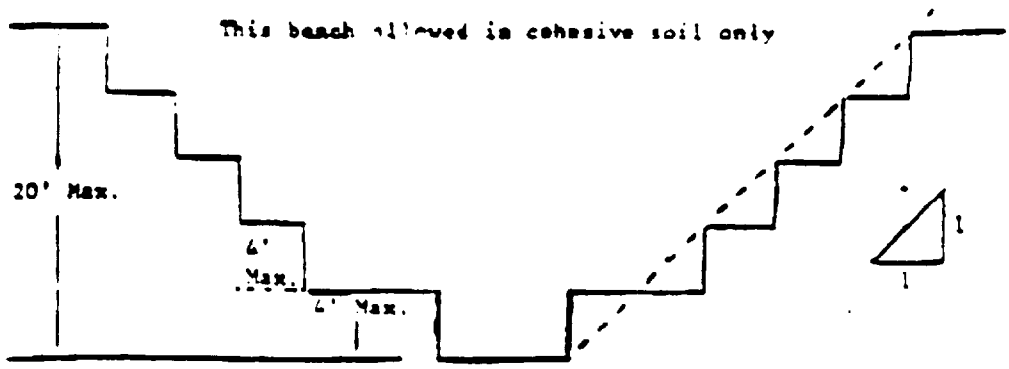


Simple Slope

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:



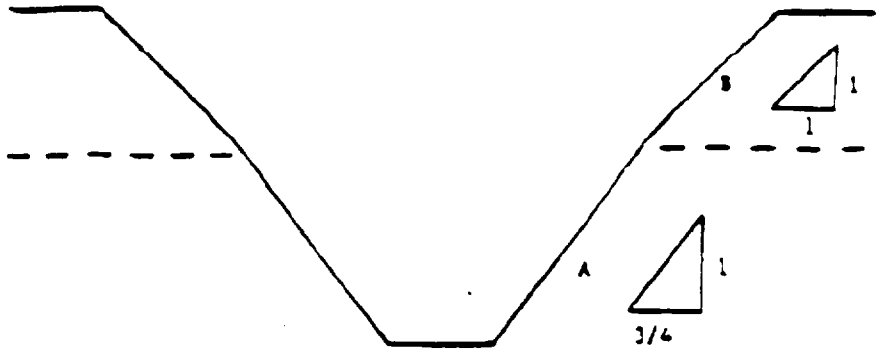
Single Bench



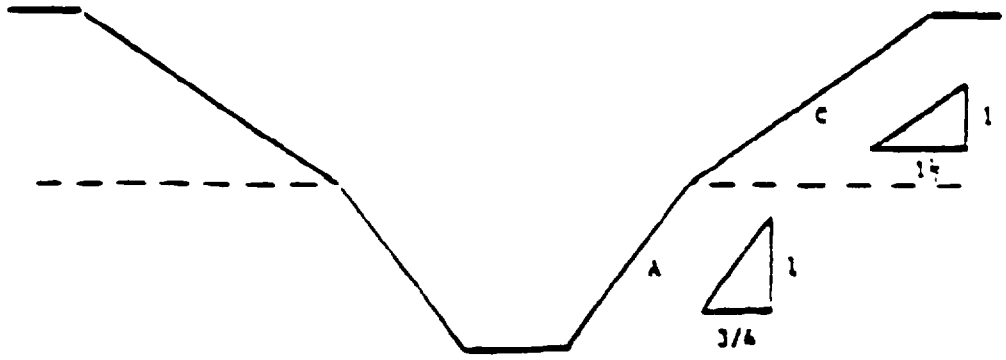
Multiple Bench

1. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

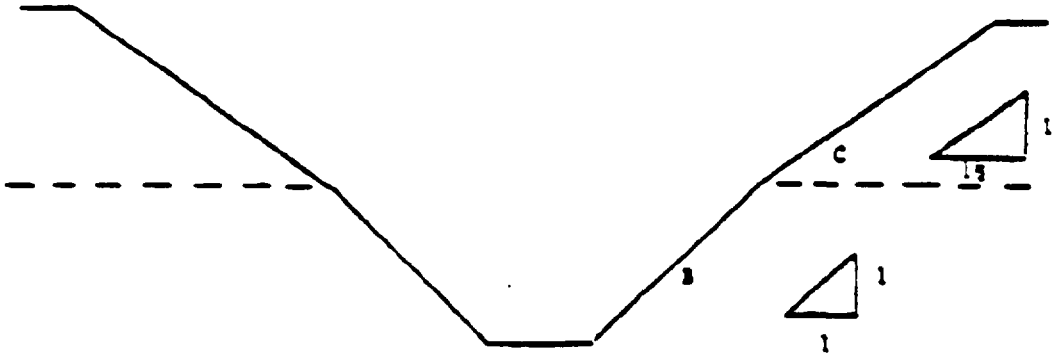
SENT BY:WESTON REGION IV TRT ;12-22-92 10:02AM ; 4042526659→ 522 499 9019;#24



B OVER A

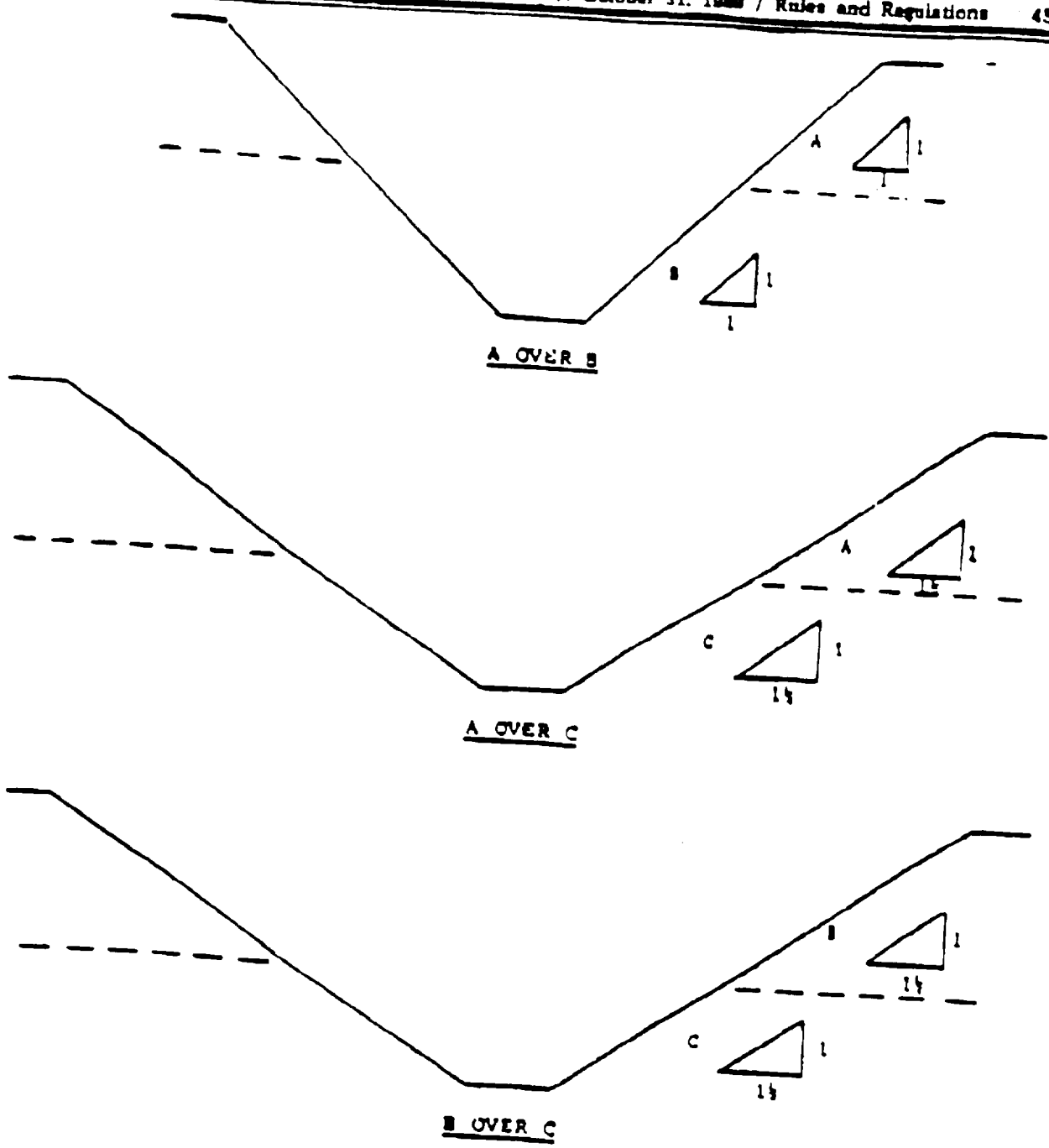


C OVER A



C OVER B

SENT BY:WESTON REGION 10 TAT ;12-23-92 10:04AM ; 4043520659→ 502 499 9019;#25



2. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

Appendix C to Subpart P

Timber Shoring for Trenches

(a) *Scope.* This appendix contains information that can be used timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with § 1926.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in § 1926.652(b) and § 1926.652(c).

(b) *Soil Classification.* In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil

classification method set forth in appendix A of subpart P of this part.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables C-1.1, C-1.2, and C-1.3, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and on the tables themselves.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data.*—(1) *Dimensions of timber members.* (i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C-2.1 through C-2.3, or have this choice under § 1926.652(c)(3), and are referred to The Corps of Engineers, The Bureau of Reclamation or data from other acceptable sources.

(2) *Limitation of application.* (i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in § 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with § 1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables.* The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to Illustrate the Use of Tables C-1.1 through C-1.3.*

(1) *Example 1.*

A trench dug in Type A soil is 13 feet deep and five feet wide.

From *Table C-1.1*, for acceptable arrangements of timber can be used.

Arrangement #1

Space 4 x 4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3 x 8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #2

Space 4 x 6 crossbraces at eight feet horizontally and four feet vertically.

Space 6 x 8 wales at four feet vertically.

Space 2 x 6 uprights at four feet horizontally.

Arrangement #3

Space 6 x 6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8 x 10 wales at four feet vertically.

Space 2 x 6 uprights at five feet horizontally.

Arrangement #4

Space 6 x 6 crossbraces at 12 feet horizontally and four feet vertically.

Space 10 x 10 wales at four feet vertically.

Space 3 x 6 uprights at six feet horizontally.

(2) *Example 2.*

A trench dug in Type B soil is 13 feet deep and five feet wide. From Table C-1.2 three acceptable arrangements of members are listed.

Arrangement #1

Space 6 x 6 crossbraces at six feet horizontally and five feet vertically.

Space 8 x 8 wales at five feet vertically.

Space 2 x 6 uprights at two feet horizontally.

Arrangement #2

Space 6 x 6 crossbraces at eight feet horizontally and five feet vertically.

Space 10 x 10 wales at five feet vertically.

Space 2 x 6 uprights at two feet horizontally.

Arrangement #3

Space 6 x 6 crossbraces at 10 feet horizontally and five feet vertically.

Space 10 x 12 wales at five feet vertically.

Space 2 x 6 uprights at two feet vertically.

(3) *Example 3.*

A trench dug in Type C soil is 13 feet deep and five feet wide.

From Table C-1.3 two acceptable arrangements of members can be used.

Arrangement #1

Space 6 x 6 crossbraces at six feet horizontally and five feet vertically.

Space 10 x 12 wales at five feet vertically.

Position 2 x 6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #2

Space 6 x 10 crossbraces at eight feet horizontally and five feet vertically.

Space 12 x 12 wales at five feet vertically.

Position 2 x 6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) *Example 4.*

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C-1.3. Only one arrangement of members is provided.

Space 6 x 10 crossbraces at six feet horizontally and five feet vertically.

Space 12 x 12 wales at five feet vertically.

Use 3 x 6 tight sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) *Notes for all Tables.*

1. Member sizes at spacings other than indicated are to be determined as specified in § 1926.652(c), "Design of Protective Systems."

SENT BY:WESTON REGION IV TRT ; 12-23-92 ; 12:

1. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.

2. All spacing indicated is measured center to center.

4. Waler to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a sheetpile shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When sheetpile are used, the vertical distance shall not exceed 42 inches. Sheetpile are walls that are installed at the use of the trench side.

6. Trench jacks may be used in lieu of a combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

BILLING CODE 4510-26-M

SENT BY:WESTON REGION 10 TAT ;12-23-92 10:07AM ; 4043520659→ 502 499 9019;#25

ATTACHMENT E

Drum Log

WESTON — MAJOR PROGRAMS DIVISION

MANAGERS / DESIGNERS/CONSULTANTS

REGION IV TECHNICAL ASSISTANCE TEAM

DRUM LOG

Page 1 / 1

Site Name: Jefferson Co. Forest — TDD #: 04-9212-0012

Location: Brooks, Bullitt Co., Ky — Weather: 64°F, clear skies, 72% humidity

Samplers: J. Mayhew, M. Mosko — Date: 10 February 1992

DRUM #	DRUM DESCRIPTION	CONTENT DESCRIPTION	FIELD CHARACTERISTICS: pH	HNU / OVA	% LEL	~~SOL*~~	SP GR* <,=,>	REAC*	FLM	~~POB~~ color	COMMENTS/REMARKS	TIME
001-04	Standard blue barrel, rusty, rolled	5-8 gallons		45	ø	20.5	NA				Gray liq	1555
001-05	"	8-10 gallons		ø	ø	20.5	NA				Bright yellow	1610
001-06	"	15-20 gallons		ø	ø	20.8	NA				appears to be motor oil.	1620

* Reference is water

ATTACHMENT F

Laboratory Analysis

WESTON 1575 Northside Dr. N.W., Suite 325, Bldg. 300, Atlanta, GA 30318 404-352-4147

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE REMOVAL AND PREVENTION
EPA CONTRACT 68-W0-0036

MEMORANDUM

TO: FILE

FROM: Paula C. MacLaren
Analytical Coordinator

THRU: Donnissa L. Duvic
TATL, Region IV

SUBJECT: Jefferson Forest Drums Site Analytical Data
TDD# 04-9302-L003-0704

DATE: 17 March 1993

Roy F. Weston, Inc. laboratory performed volatile, semivolatile and target analyte list metal analyses on one soil, two sediment and three liquid waste samples collected from the Jefferson Forest Drums site on 10 February 1993. Due to limited sample volume, the laboratory was only able to perform duplicate analyses for soil volatile compounds. In addition, prior to the semivolatile analysis, liquid waste sample JCF-05 separated into two phases; one oil and one water. Both phases were analyzed for semivolatile compounds. The sample data package was required within a two week time period.

The analytical report was received seven days late incurring a 10% penalty fee on the total invoice cost.

The laboratory blank revealed methylene chloride contamination during the organic analyses. The effect on reported sample values was evaluated and presented in the attached data summary.

All extraction and analyses hold times were met (hold times have not been established for drum waste samples.)

Volatile analysis showed some matrix interferences for soil and oil samples with 5 out of 12 surrogate percent recoveries slightly exceeding method QC limits. The blank matrix spike percent recoveries, however, were all within limits; verifying the analytical process. Semivolatile analysis showed no matrix interferences with all surrogate spike percent recoveries within

analytical process. Semivolatile analysis showed no matrix interferences with all surrogate spike percent recoveries within method QC limits.

Metal soil matrix spike/matrix spike duplicates showed several percent recoveries exceeding the QA/QC 80%-120% guideline. Showing lower percent recoveries due to matrix interferences were arsenic, antimony, cadmium, chromium and selenium. Arsenic, antimony and chromium also showed wide variances in reproducible data with relative percent differences (RPD) exceeding the 20% guideline. Due to elevated sample concentrations, spike percent recoveries for aluminum, calcium, copper, iron, magnesium, manganese, nickel, lead and zinc were not applicable. All metal laboratory control samples were within limits to verify the analytical process.

Metal liquid waste matrix spikes only showed thallium to experience a matrix interference with a percent recovery below the recommended 80%. Due to elevated sample concentrations, spike percent recoveries for iron, lead and zinc were not applicable. All other matrix spike percent recoveries were within limits. All metal laboratory control samples were within limits to verify the analytical process.

Some samples were diluted due to matrix interferences. Note the elevated reporting limits for volatile analysis on samples JCF-04, JCF-06 and semivolatile analysis on samples JCF-05 (oil) and JCF-06.

A summary of the data can be found on the following pages.

cc: Gail Scoggins
Matt Manka

JEFFERSON FOREST DRUMS SITE
ANALYTICAL DATA

Sediment and Soil Samples

ORGANIC COMPOUNDS (ug/kg)

SAMPLE ID	JCF-01	JCF-02	JCF-03	JCF-03
MATRIX	SEDIMENT	SEDIMENT	SOIL	DUPLICATE
Methylene Chloride	5 J	3 J		U
Phenanthrene			100 J	-
Fluoranthene			110 J	-
Pyrene			110 J	-
bis(2-Ethylhexyl) phthalate			280 J	-
Benzo(g,h,i)perylene			51 J	-

NOTES:

J - ESTIMATED VALUE; COMPOUND CONCENTRATION IS BELOW THE REPORTING LIMIT

U - UNDETECTED; COMPOUND PRESENT IN LABORATORY BLANK

"-" - NOT ANALYZED

JEFFERSON FOREST DRUMS SITE
ANALYTICAL DATA

Sediment and Soil Samples

METALS (mg/kg)

SAMPLE ID	JCF-01	JCF-02	JCF-03
MATRIX	SEDIMENT	SEDIMENT	SOIL
Aluminum	11000	8670	17700
Antimony			15.4
Arsenic	20.5	23.1	7.1
Barium	51.6	39.5	230
Beryllium	0.95	0.74	
Cadmium			2.9
Calcium	834	753	8440
Chromium, Total	21.0	14.0	48.2
obalt	29.8	26.4	10.8
Copper	28.1	17.3	157
Cyanide, Total			0.91
Iron	62200	40700	41400
Lead	29.3	27.1	1730
Magnesium	3010	2650	3400
Manganese	760	658	480
Mercury	0.04	0.04	0.39
Nickel	57.2	46.8	38.9
Potassium	1630	1330	1720
Sodium			1440
Vanadium	35.9	24.9	27.3
Zinc	152	103	1220

JEFFERSON FOREST DRUMS SITE
ANALYTICAL DATA

Waste Samples

ORGANIC COMPOUNDS (ug/kg)

SAMPLE ID	JCF-04	JCF-05	JCF-05	JCF-06
MATRIX	OIL	OIL	WATER	OIL
Methylene Chloride	U		-	U
Toluene	56 J		-	
Ethylbenzene	3300		-	
Xylene, Total	14000		-	
Phenol			270 J	
Naphthalene	350 J			
2-Methylnapthalene	350 J			
Benzoic Acid			2600	
Phenanthrene	200 J			
bis(2-Ethylhexyl) phthalate	310 J			

NOTES:

U - UNDETECTED; COMPOUND WAS PRESENT IN LABORATORY BLANK

J - ESTIMATED VALUE; COMPOUND CONCENTRATION IS BELOW THE REPORTING LIMIT

"-" - NOT ANALYZED

JEFFERSON FOREST DRUMS SITE
ANALYTICAL DATA

Waste Samples

METALS(mg/kg)

SAMPLE ID	JCF-04	JCF-05	JCF-06
MATRIX	OIL	OIL	OIL
Aluminum	92.4	20.3	
Arsenic	1.5	99.2	
Barium	25.3	25.9	134
Cadmium	0.71		
Chromium, Total	3.5	1.3	
Cyanide, Total	1.4		
Iron	1300	95.3	48.0
Lead	48.6	1.4	12.6
Manganese	7.9	1.9	
Mercury	0.04		
Potassium		4550	
Sodium	3020		
Zinc	30.1	131	223

U. S. ENVIRONMENTAL PROTECTION AGENCY
REGION 4 TAT

93 02 S 099

RECEIVED FEB 19 1993

CHAIN OF CUSTODY RECORD

ENVIRONMENTAL SERVICES DIVISION
COLLEGE STATION ROAD
ATHENS, GEORGIA 30613

PROJ NO

PROJECT NAME: Jefferson Forest Drum S.

SAMPLERS (Signature): Jim May

Water/Wastewater | Sediment/Soil | Waste | Misc

Circle/add Parameters Desired ( ) : Indicates Separate Containers

LAB ID	STA NO	DATE	TIME	COMP	GRAB	STATION LOCATION	NO OF CONTAINERS	(Oil & Grease)	(Total org. Phenol) (EPA) (Metals)	(Total Alk)	250 ml Q (TOC)	P (Total TSS Cl, Fl, Sol. etc)	N.O (ammonia) (Total Q) (Total)	N.P (total Metals) (Total Hardness) (Total COD N P etc)	0.5-N.P (ST)	% Solid or N.P (Chl)	4 oz Q (Total Metals)	4 oz Q (Total Metals)	P or Q (Total Metals)	P or Q (Total Metals)	1 L Q (Total Metals)	1 L Q	4 oz Q (EPA) (Total Metals)	REMARKS/TAG NUMBERS
001	JCF-01	2/10/93	1520	✓			3										2	1						T4-07306, 07, 08
002	JCF-02	2/10/93	1530	✓			3										2	1						T4-04638, 07305, 07498
003	JCF-03	2/10/93	1545	✓			2												1	1				T4-07309, 10
004	JCF-04	2/10/93	1555		✓		2												1	1				T4-07311, 12
005	JCF-05	2/10/93	1610		✓		2												1	1				T4-07313, 14
006	JCF-06	2/10/93	1620		✓		2												1	1				T4-07315, 16

Custody Seal Intact
T=4°C

Relinquished by (Signature)	Date/Time	Received by (Signature)	Relinquished by (Signature)	Date/Time	Received by (Signature)
Jim M	2/11/93 1600	Federal Express	Airbill #	2/12/93 0830	M. Clay
Relinquished by (Signature)	Date/Time	Received by (Signature)	Relinquished by (Signature)	Date/Time	Received by (Signature)

Remarks: Roy F. Weston, Inc Lab
212 Frank West Circle
Suite A
Stockton, CA 95206

* Analyze for TAL metals
* Sample JCF-06 should also be analyzed for PCBs.

DISTRIBUTION: Original and Pink copies accompany sample shipment to laboratory. Pink copy returned by laboratory. Yellow copy retained by samplers. Blue copy extra copy as needed.

Airbill # 6137 68 7113
Hrz Airbill # 9123518541

T4-0351 * No positive

WESTON
212 FRANK WEST CIRCLE
SUITE A
STOCKTON, CA 95206
PHONE: (209) 983-1340
FAX: 209-983-0304

4 March 1993

Ms. Paula Maclaren
Roy F. Weston, Inc.
Building 300, Suite 325
Atlanta Technology Center
1575 Northside Drive, NW
Atlanta, GA 30318-4208

RECEIVED
MAR 0 9 1993

Work Order No.00000-000-000-0

TDD#04-9302-0003-0704

RE: Jefferson Forest Analytical Results
RFW Batch: 9302S099

Dear Ms. Maclaren:

Enclosed are the laboratory results for samples submitted to Weston Analytics Division.

Non-hazardous samples will be disposed of by the laboratory 30 days after the final report is issued at no charge. Hazardous samples which are inconsistent with laboratory waste streams will be returned to you.

If you have any questions, please call me at (209) 983-1340.

Very truly yours,

ROY F. WESTON, INC.

Laurie J. Cullen
Project Manager

LJC/paj

Enclosure

Approved by:

Irving M. Kipnis, Ph.D., C.I.H.
Laboratory Manager

WESTON

STANDARD - GLOSSARY OF DATA QUALIFIERS AND ABBREVIATIONS

MAR 0 9 1993

Inorganic Data Qualifiers

U Analyte was not detected at or above the reporting limit

X Result obtained indirectly through calculation based on results from other analyses

Organic Data Qualifiers

B Compound was found in the blank and the sample

D Surrogate or matrix spike recoveries were not obtained because the extract was diluted for analysis

E Concentration exceeds the instrument calibration range and was subsequently diluted

I Appears on the "results spreadsheet" to indicate an interference

J Result is an estimated value below the reporting limit or a tenatively identified compound (TIC)

T Compound was found in the TCLP extraction blank and the sample

U Compound was not detected at or above the reporting limit

Abbreviations

BS Blank Spike: spike analysis was conducted on reagent grade water or a matrix free from the analyte(s) of interest.

BSD Blank Spike Duplicate

BRL Below Reporting Limit

CD Calculation Factor used by the laboratory's Information Management System (LIMS)

DF Dilution Factor

DL Appears in the sample ID to indicate a secondary dilution was performed

LCS or (LC) denotes Laboratory Control Standard

MB Method Blank or (PB) preparation blank

MS Matrix Spike

MSD Matrix Spike Duplicate

NA Not Applicable

NR Not Required

NS Not Spiked

RE Appears in the sample ID to indicate a Re-analysis

REP Replicate analysis

REPREP Sample was reprepared and then reanalyzed

RFW# Equivalent to the laboratory sample identification (LAB ID)

RPD Relative Percent Difference of duplicate analyses

RRF Relative Response Factor

RT Retention Time

RTW Retention Time Window

NOTES:

- One or a combination of these data qualifiers and abbreviations may appear in the analytical report.
- Soil, sediment and sludge results are reported on a dry weight basis except when analyzed for landfill disposal or incineration parameters. All other results on a solid matrix are reported on an "as received" basis unless noted differently.
- Reporting limits are adjusted for preparation sample size, sample dilutions and sample moisture content if analyzed on a dry weight basis.

Revised 12/02/92

ROY F. WESTON, INC.
STOCKTON ANALYTICAL LABORATORY
ANALYTICAL CASE NARRATIVE

MAR 0 9 1993

Client: JEFFERSON FOREST DRUM ST
RFW #: 9302S099

Test: GC/MS Volatiles

1. This narrative covers the analysis of 1 soil, 2 sediment and 3 oil samples for volatiles in accordance with EPA SW-846 Method 8240.

2. All required hold times were met.

3. The method blanks associated with these samples were free from target analyte interferences at or above the reporting limits.

4. The tuning and standard calibrations were within QC guidelines.

5. The internal standard areas and retention times were all within QC guidelines with the exception of the initial analysis of sample JCF-03 and JCF-03RE which had one low internal standard area. Matrix effects are indicated.

6. The surrogate recoveries were within laboratory limits with the exception of the reanalysis of sample JCF-03 and both initial and reanalysis of sample JCF-04.

7. The blank spike recoveries were within laboratory limits.

8. Methylene chloride reported in spikes was a lab contaminant.

9. Sample JCF-05 could not be run more concentrated due to high amounts of non-target compounds.

Walt McCurdy
W.C. McCurdy
Unit Leader

2-28-93
Date

WESTON

Roy F. Weston, Inc. - Stockton Laboratory
VOA ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT = :9302S099

CLIENT ID	RFW #		MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS	LIST
JCF-01	001		SE	93SMA044	02/10/93	02/19/93	02/19/93	0624HA
JCF-02	002		SE	93SMA044	02/10/93	02/19/93	02/19/93	0624HA
JCF-03	003		S	93SMA044	02/10/93	02/19/93	02/19/93	0624HA
JCF-03	003	R1	S	93SMA046	02/10/93	02/22/93	02/22/93	0624HA
JCF-04	004	M1	OI	93SMA050	02/10/93	02/24/93	02/24/93	0624HA
JCF-04	004	M2	OI	93SMA050	02/10/93	02/24/93	02/24/93	0624HA
JCF-05	005		OI	93SMA49A	02/10/93	02/24/93	02/24/93	0624HA
JCF-06	006	M1	OI	93SMA050	02/10/93	02/24/93	02/24/93	0624HA
LAB QC:								
VBLKA044	MB1		S	93SMA044	02/19/93	02/19/93	02/19/93	0624HA
VBLKA044	MB1	BS	S	93SMA044	02/19/93	02/19/93	02/19/93	0624HA
VBLKA046	MB1		S	93SMA046	02/22/93	02/22/93	02/22/93	0624HA
VBLKA046	MB1	BS	S	93SMA046	02/22/93	02/22/93	02/22/93	0624HA
VBLKA050	MB1		S	93SMA050	02/24/93	02/24/93	02/24/93	0624HA
VBLK49A	MB1		S	93SMA49A	02/24/93	02/24/93	02/24/93	0624HA
VBLK49A	MB1	BS	S	93SMA49A	02/24/93	02/24/93	02/24/93	0624HA

Roy F. Weston, Inc. Stockton Laboratory

Volatiles by GC/MS, HSL List

RFW Batch Number: 9302S099 Client: JEFFERSON FOREST DRUM ST Work Order: 00000-000-000-0 Report Date: 02/26/93 15:59 Page: 1a

MAR 09 1993

Sample Information	Cust ID:	JCF-01	JCF-02	JCF-03	JCF-03	JCF-04	JCF-04
	RFW#:	001	099-002	099-003	099-003	099-004	099-004 DL
	Matrix:	SEDIMENT	SEDIMENT	SOIL	SOIL	OIL	OIL
	D.F.:	1.00	1.00	1.00	1.00	1.25	1.25
	Units:	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg
	Level:	LOW	LOW	LOW	LOW REPREP	MED	MED
Surrogate Recovery	Toluene-d8	97 %	99 %	100 %	123 * %	70 * %	76 * %
	Bromofluorobenzene	83 %	97 %	75 %	86 %	76 %	80 %
	1,2 Dichloroethane-d4	108 %	119 %	107 %	116 %	69 * %	69 * %
Chloromethane		15 U	15 U	14 U	14 U	1200 U	NA
Bromomethane		15 U	15 U	14 U	14 U	1200 U	NA
Vinyl Chloride		15 U	15 U	14 U	14 U	1200 U	NA
Chloroethane		15 U	15 U	14 U	14 U	1200 U	NA
Methylene Chloride		5 J	3 J	7 U	2 JB	130 JB	300 JB
Acetone		15 U	15 U	14 U	14 U	1200 U	NA
Carbon Disulfide		8 U	8 U	7 U	7 U	620 U	NA
1,1-Dichloroethene		8 U	8 U	7 U	7 U	620 U	NA
1,1-Dichloroethane		8 U	8 U	7 U	7 U	620 U	NA
1,2-Dichloroethene (total)		8 U	8 U	7 U	7 U	620 U	NA
Chloroform		8 U	8 U	7 U	7 U	620 U	NA
1,2-Dichloroethane		8 U	8 U	7 U	7 U	620 U	NA
2-Butanone		15 U	15 U	14 U	14 U	1200 U	NA
1,1,1-Trichloroethane		8 U	8 U	7 U	7 U	620 U	NA
Carbon Tetrachloride		8 U	8 U	7 U	7 U	620 U	NA
Vinyl Acetate		15 U	15 U	14 U	14 U	1200 U	NA
Bromodichloromethane		8 U	8 U	7 U	7 U	620 U	NA
1,2-Dichloropropane		8 U	8 U	7 U	7 U	620 U	NA
cis-1,3-Dichloropropene		8 U	8 U	7 U	7 U	620 U	NA
Trichloroethene		8 U	8 U	7 U	7 U	620 U	NA
Dibromochloromethane		8 U	8 U	7 U	7 U	620 U	NA
1,1,2-Trichloroethane		8 U	8 U	7 U	7 U	620 U	NA
Benzene		8 U	8 U	7 U	7 U	620 U	NA
trans-1,3-Dichloropropene		8 U	8 U	7 U	7 U	620 U	NA
Bromoform		8 U	8 U	7 U	7 U	620 U	NA
4-Methyl-2-pentanone		15 U	15 U	14 U	14 U	1200 U	NA
2-Hexanone		15 U	15 U	14 U	14 U	1200 U	NA
Tetrachloroethene		8 U	8 U	7 U	7 U	620 U	NA
1,1,2,2-Tetrachloroethane		8 U	8 U	7 U	7 U	620 U	NA

*= Outside of Advisory limits.

RFW Bat Number: 93025099 Client: JEFFERSON FORE DRUM ST Work Order: 00000-000-000-0 Pe : 1b

Cust ID:	JCF-01	JCF-02	JCF-03	JCF-03	JCF-04	JCF-04
RFW#:	001	099-002	099-003	099-003	099-004	099-004 DL
Level:	LOW	LOW	LOW	LOW REPREP	MED	MED
Toluene	8 U	8 U	7 U	7 U	56 J	NA
Chlorobenzene	8 U	8 U	7 U	7 U	620 U	NA
Ethylbenzene	8 U	8 U	7 U	7 U	3100	3300
Styrene	8 U	8 U	7 U	7 U	620 U	NA
Xylene (total)	8 U	8 U	7 U	7 U	14000	14000

*= Outside of Advisory limits.

RECEIVED
MAR 0 9 1993

Roy F. Weston, Inc. Stockton Laboratory
Volatiles by GC/MS, HSL List

RFW Batch Number: 9302S099 Client: JEFFERSON FOREST DRUM ST Work Order: 00000-000-000-0 Report Date: 02/26/93 15:59 Page: 2a

MAR 09 93

Sample Information													
	Cust ID:	JCF-05		JCF-06		VBLKA044		VBLKA044 BS		VBLKA046		VBLKA046 BS	
	RFW#:	099-005		099-006		93SMA044-MB1		93SMA044-MB1		93SMA046-MB1		93SMA046-MB1	
	Matrix:	OIL		OIL		SOIL		SOIL		SOIL		SOIL	
	D.F.:	20.0		1.25		1.00		1.00		1.00		1.00	
	Units:	ug/Kg		ug/Kg		ug/Kg		ug/Kg		ug/Kg		ug/Kg	
	Level:	LOW		MED		LOW		LOW		LOW		LOW	
Surrogate Recovery	Toluene-d8	100	%	88	%	99	%	107	%	104	%	107	%
	Bromofluorobenzene	108	%	94	%	89	%	105	%	89	%	117	%
	1,2-Dichloroethane-d4	104	%	95	%	102	%	108	%	111	%	113	%
			fl		fl		fl		fl		fl		fl
Chloromethane		200	U	1200	U	10	U	10	U	10	U	10	U
Bromomethane		200	U	1200	U	10	U	10	U	10	U	10	U
Vinyl Chloride		200	U	1200	U	10	U	10	U	10	U	10	U
Chloroethane		200	U	1200	U	10	U	10	U	10	U	10	U
Methylene Chloride		100	U	660	B	5	U	40		4	J	46	B
Acetone		200	U	1200	U	10	U	10	U	10	U	10	U
Carbon Disulfide		100	U	620	U	5	U	5	U	5	U	5	U
1,1-Dichloroethene		100	U	620	U	5	U	122	%	5	U	124	%
1,1-Dichloroethane		100	U	620	U	5	U	5	U	5	U	5	U
1,2-Dichloroethene (total)		100	U	620	U	5	U	5	U	5	U	5	U
Chloroform		100	U	620	U	5	U	5	U	5	U	5	U
1,2-Dichloroethane		100	U	620	U	5	U	5	U	5	U	5	U
2-Butanone		200	U	1200	U	10	U	10	U	10	U	10	U
1,1,1-Trichloroethane		100	U	620	U	5	U	5	U	5	U	5	U
Carbon Tetrachloride		100	U	620	U	5	U	5	U	5	U	5	U
Vinyl Acetate		200	U	1200	U	10	U	10	U	10	U	10	U
Bromodichloromethane		100	U	620	U	5	U	5	U	5	U	5	U
1,2-Dichloropropane		100	U	620	U	5	U	5	U	5	U	5	U
cis-1,3-Dichloropropene		100	U	620	U	5	U	5	U	5	U	5	U
Trichloroethene		100	U	620	U	5	U	102	%	5	U	114	%
Dibromochloromethane		100	U	620	U	5	U	5	U	5	U	5	U
1,1,2-Trichloroethane		100	U	620	U	5	U	5	U	5	U	5	U
Benzene		100	U	620	U	5	U	106	%	5	U	107	%
trans-1,3-Dichloropropene		100	U	620	U	5	U	5	U	5	U	5	U
Bromoform		100	U	620	U	5	U	5	U	5	U	5	U
4-Methyl-2-pentanone		200	U	1200	U	10	U	10	U	10	U	10	U
2-Hexanone		200	U	1200	U	10	U	10	U	10	U	10	U
Tetrachloroethene		100	U	620	U	5	U	5	U	5	U	5	U
1,1,2,2-Tetrachloroethane		100	U	620	U	5	U	5	U	5	U	5	U

*= Outside of Advisory limits.

RFW Bat Number: 9302S099 Client: JEFFERSON FORE DRUM ST Work Order: 00000-000-000-0 Page: 2b

Cust ID:	JCF-05		JCF-06		VBLKA044		VBLKA044 BS		VBLKA046		VBLKA046 BS	
RFW#:	099-005		099-006		93SMA044-MB1		93SMA044-MB1		93SMA046-MB1		93SMA046-MB1	
Level:	LOW		MED		LOW		LOW		LOW		LOW	
Toluene	100	U	620	U	5	U	105	%	5	U	110	%
Chlorobenzene	100	U	620	U	5	U	102	%	5	U	111	%
Ethylbenzene	100	U	620	U	5	U	5	U	5	U	5	U
Styrene	100	U	620	U	5	U	5	U	5	U	5	U
Xylene (total)	100	U	620	U	5	U	5	U	5	U	5	U

*= Outside of Advisory limits.

MAR 0 9 1993

Roy F. Weston, Inc. Stockton Laboratory
Volatiles by GC/MS, HSL List

RFW Batch Number: 9302S099 Client: JEFFERSON FOREST DRUM ST Work Order: 00000-000-000-0 Report Date: 02/26/93 15:59 Page: 3a

MAR 0 9 1993

Sample Information

Cust ID:	VBLK49A	VBLK49A BS	VBLKA050
RFW#:	93SMA49A-MB1	93SMA49A-MB1	93SMA050-MB1
Matrix:	SOIL	SOIL	SOIL
D.F.:	1.00	1.00	1.25
Units:	ug/Kg	ug/Kg	ug/Kg
Level:	LOW	LOW	MED

Surrogate Recovery	Toluene-d8	109 %	106 %	106 %		
	Bromofluorobenzene	113 %	104 %	108 %		
	1,2 Dichloroethane-d4	101 %	100 %	92 %		
Chloromethane		10 U	10 U	1200 U		
Bromomethane		10 U	10 U	1200 U		
Vinyl Chloride		10 U	10 U	1200 U		
Chloroethane		10 U	10 U	1200 U		
Methylene Chloride		3 J	5 U	790		
Acetone		10 U	10 U	1200 U		
Carbon Disulfide		5 U	5 U	620 U		
1,1 Dichloroethene		5 U	97 %	620 U		
1,1 Dichloroethane		5 U	5 U	620 U		
1,2 Dichloroethene (total)		5 U	5 U	620 U		
Chloroform		5 U	5 U	620 U		
1,2 Dichloroethane		5 U	5 U	620 U		
2 Butanone		10 U	10 U	1200 U		
1,1,1-Trichloroethane		5 U	5 U	620 U		
Carbon Tetrachloride		5 U	5 U	620 U		
Vinyl Acetate		10 U	10 U	1200 U		
Bromodichloromethane		5 U	5 U	620 U		
1,2-Dichloropropane		5 U	5 U	620 U		
cis-1,3-Dichloropropene		5 U	5 U	620 U		
Trichloroethene		5 U	93 %	620 U		
Dibromochloromethane		5 U	5 U	620 U		
1,1,2-Trichloroethane		5 U	5 U	620 U		
Benzene		5 U	96 %	620 U		
trans-1,3-Dichloropropene		5 U	5 U	620 U		
Bromoform		5 U	5 U	620 U		
4-Methyl-2-pentanone		10 U	10 U	1200 U		
2-Hexanone		10 U	10 U	1200 U		
Tetrachloroethene		5 U	5 U	620 U		
1,1,2,2-Tetrachloroethane		5 U	5 U	620 U		

*= Outside of Advisory limits.

Cust ID:	VBLK49A		VBLK49A BS		VBLKA050	
RFW#:	93SMA49A-MB1		93SMA49A-MB1		93SMA050-MB1	
Level:	LOW		LOW		MED	
Toluene	5	U	104	%	620	U
Chlorobenzene	5	U	99	%	620	U
Ethylbenzene	5	U	5	U	620	U
Styrene	5	U	5	U	620	U
Xylene (total)	5	U	5	U	620	U

*= Outside of Advisory Limits.

MAR 0 9 1993

ROY F. WESTON, INC.
STOCKTON ANALYTICAL LABORATORY
ANALYTICAL CASE NARRATIVE

Client: JEFFERSON FOREST DRUM ST
RFW #: 9302S099

Test: GC/MS SEMIVOLATILES

1. This narrative covers the analysis of 2 sediment and 4 oil samples for semivolatiles in accordance with EPA SW-846 Method 8270. Sample JCF-05 had both oil and water phases, and both phases were analyzed separately.

2. All required analytical hold times were met.

3. The method blanks associated with these samples were free from target analyte interferences at or above the reporting limits.

4. The tuning and standard calibrations were within QC guidelines.

5. The internal standard areas and retention times were all within QC guidelines, with the exceptions of JCF-05 (water and oil phases) and JCF-06, which each had one or more low standard recoveries. All were analyzed at two dilutions, and matrix effects were shown. JCF-04 also had a low standard, but no target compounds were affected, so a reanalysis was not performed.

6. The surrogate recoveries were within laboratory limits, although 4 surrogates were diluted out in sample JCF-05DL. Surrogates were not used in samples JCF-06 and JCF-05 (soil phase only).

7. The blank spike recoveries and RPD values were within laboratory limits.

W.C. McCurdy
Unit Leader

3-4-93
Date

Roy F. Weston, Inc. - Stockton Laboratory
BNA ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID	RFW #		MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS	LIST
JCF-01	001		SE	93SE1810	02/10/93	02/18/93	02/23/93	0625HA
JCF-02	002		SE	93SE1810	02/10/93	02/18/93	02/24/93	0625HA
JCF-03	003		S	93SE1829	02/10/93	02/23/93	03/02/93	0625HA
JCF-04	004		W	93SE1849	02/10/93	03/01/93	03/02/93	0625HA
JCF-05	005		W	93SE1849	02/10/93	03/01/93	03/02/93	0625HA
JCF-05	005	01	W	93SE1849	02/10/93	03/01/93	03/02/93	0625HA
JCF-06	006		OI	93SE1850	02/10/93	03/01/93	03/03/93	0625HD
JCF-06	006	01	OI	93SE1850	02/10/93	03/01/93	03/02/93	0625HD
JCF-05/OIL	007		OI	93SE1850	02/10/93	03/01/93	03/03/93	0625HD
JCF-05/OIL	007	01	OI	93SE1850	02/10/93	03/01/93	03/02/93	0625HD

LAB QC:

SBLK1810	MB1		S	93SE1810	02/18/93	02/18/93	02/23/93	0625HA
SBLK1810	MB1	BS	S	93SE1810	02/18/93	02/18/93	02/23/93	0625HA
SBLK1829	MB1		S	93SE1829	02/23/93	02/23/93	03/02/93	0625HA
SBLK1829	MB1	BS	S	93SE1829	02/23/93	02/23/93	03/02/93	0625HA
SBLK1849	MB1		W	93SE1849	03/01/93	03/01/93	03/02/93	0625HA
SBLK1849	MB1	BS	W	93SE1849	03/01/93	03/01/93	03/02/93	0625HA
SBLK1850	MB1		S	93SE1850	03/01/93	03/01/93	03/02/93	0625HD

Roy F. Weston, Inc. Stockton Laboratory

Semivolatiles by GC/MS, HSL list

RFW Batch Number: 93SE1810 Client: LAB Work Order: NONE Report Date: 03/04/93 14:11 Page: 1a

MAR 0 9 1993

	Cust ID:	SBLK1810		SBLK1829		SBLK1849		SBLK1810 BS		SBLK1829 BS		SBLK1849 BS	
Sample Information	RFW#:	MB1		93SE1829-MB1		93SE1849-MB1		93SE1810-MB1		93SE1829-MB1		93SE1849-MB1	
	Matrix:	SOIL		SOIL		WATER		SOIL		SOIL		WATER	
	D.F.:	2.00		1.00		1.00		1.00		1.00		1.00	
	Units:	ug/Kg		ug/Kg		ug/L		ug/Kg		ug/Kg		ug/L	
Surrogate Recovery	Nitrobenzene-d5	90	%	84	%	78	%	81	%	79	%	90	%
	2-Fluorobiphenyl	102	%	86	%	66	%	87	%	81	%	68	%
	Terphenyl-d14	113	%	80	%	70	%	107	%	77	%	76	%
	Phenol-d5	104	%	80	%	37	%	82	%	71	%	36	%
	2-Fluorophenol	77	%	72	%	39	%	72	%	69	%	47	%
	2,4,6-Tribromophenol	89	%	73	%	68	%	86	%	74	%	66	%
			fl		fl		fl		fl		fl		fl
Phenol		670	U	330	U	10	U	76	%	67	%	31	%
bis(2-Chloroethyl)ether		670	U	330	U	10	U	330	U	330	U	10	U
2-Chlorophenol		670	U	330	U	10	U	78	%	65	%	66	%
1,3-Dichlorobenzene		670	U	330	U	10	U	330	U	330	U	10	U
1,4-Dichlorobenzene		670	U	330	U	10	U	75	%	74	%	70	%
Benzyl alcohol		670	U	330	U	10	U	330	U	330	U	10	U
1,2-Dichlorobenzene		670	U	330	U	10	U	330	U	330	U	10	U
2-Methylphenol		670	U	330	U	10	U	330	U	330	U	10	U
bis(2-Chloroisopropyl)ether		670	U	330	U	10	U	330	U	330	U	10	U
4 Methylphenol		670	U	330	U	10	U	330	U	330	U	10	U
N Nitroso-di-n-propylamine		670	U	330	U	10	U	79	%	82	%	83	%
Hexachloroethane		670	U	330	U	10	U	330	U	330	U	10	U
Nitrobenzene		670	U	330	U	10	U	330	U	330	U	10	U
Isophorone		670	U	330	U	10	U	330	U	330	U	10	U
2-Nitrophenol		670	U	330	U	10	U	330	U	330	U	10	U
2,4-Dimethylphenol		670	U	330	U	10	U	330	U	330	U	10	U
Benzoic acid		3300	U	1700	U	50	U	1700	U	1700	U	50	U
bis(2-Chloroethoxy)methane		670	U	330	U	10	U	330	U	330	U	10	U
2,4-Dichlorophenol		670	U	330	U	10	U	330	U	330	U	10	U
1,2,4-Trichlorobenzene		670	U	330	U	10	U	83	%	69	%	66	%
Naphthalene		670	U	330	U	10	U	330	U	330	U	10	U
4-Chloroaniline		670	U	330	U	10	U	330	U	330	U	10	U
Hexachlorobutadiene		670	U	330	U	10	U	330	U	330	U	10	U
4-Chloro-3-methylphenol		670	U	330	U	10	U	79	%	61	%	71	%
2-Methylnaphthalene		670	U	330	U	10	U	330	U	330	U	10	U
Hexachlorocyclopentadiene		670	U	330	U	10	U	330	U	330	U	10	U

*= Outside of Advisory limits.

RFW Bat Number: 93SE1810 Client: LAB Work Order: NONE P : 1b

Cust ID:	SBLK1810		SBLK1829		SBLK1849		SBLK1810 BS		SBLK1829 BS		SBLK1849 BS	
RFW#:	MB1		93SE1829-MB1		93SE1849-MB1		93SE1810-MB1		93SE1829-MB1		93SE1849-MB1	
2,4,6-Trichlorophenol	670	U	330	U	10	U	330	U	330	U	10	U
2,4,5-Trichlorophenol	3300	U	1700	U	50	U	1700	U	1700	U	50	U
2-Chloronaphthalene	670	U	330	U	10	U	330	U	330	U	10	U
2-Nitroaniline	3300	U	1700	U	50	U	1700	U	1700	U	50	U
Dimethylphthalate	670	U	330	U	10	U	330	U	330	U	10	U
Acenaphthylene	670	U	330	U	10	U	330	U	330	U	10	U
2,6-Dinitrotoluene	670	U	330	U	10	U	330	U	330	U	10	U
3-Nitroaniline	3300	U	1700	U	50	U	1700	U	1700	U	50	U
Acenaphthene	670	U	330	U	10	U	85	%	72	%	74	%
2,4-Dinitrophenol	3300	U	1700	U	50	U	1700	U	1700	U	50	U
4-Nitrophenol	3300	U	1700	U	50	U	101	%	75	%	40	%
Dibenzofuran	670	U	330	U	10	U	330	U	330	U	10	U
2,4-Dinitrotoluene	670	U	330	U	10	U	86	%	80	%	76	%
Diethylphthalate	670	U	330	U	10	U	330	U	330	U	10	U
4-Chlorophenyl-phenylether	670	U	330	U	10	U	330	U	330	U	10	U
Fluorene	670	U	330	U	10	U	330	U	330	U	10	U
4-Nitroaniline	3300	U	1700	U	50	U	1700	U	1700	U	50	U
4,6-Dinitro-2-methylphenol	3300	U	1700	U	50	U	1700	U	1700	U	50	U
N-Nitrosodiphenylamine (1)	670	U	330	U	10	U	330	U	330	U	10	U
4-Bromophenyl-phenylether	670	U	330	U	10	U	330	U	330	U	10	U
Hexachlorobenzene	670	U	330	U	10	U	330	U	330	U	10	U
Pentachlorophenol	3300	U	1700	U	50	U	87	%	66	%	63	%
Phenanthrene	670	U	330	U	10	U	330	U	330	U	10	U
Anthracene	670	U	330	U	10	U	330	U	330	U	10	U
Di-n-butylphthalate	670	U	330	U	10	U	330	U	330	U	10	U
Fluoranthene	670	U	330	U	10	U	330	U	330	U	10	U
Pyrene	670	U	330	U	10	U	103	%	72	%	82	%
Butylbenzylphthalate	670	U	330	U	10	U	330	U	330	U	10	U
3,3'-Dichlorobenzidine	1300	U	670	U	20	U	670	U	670	U	20	U
Benzo(a)anthracene	670	U	330	U	10	U	330	U	330	U	10	U
Chrysene	670	U	330	U	10	U	330	U	330	U	10	U
bis(2-Ethylhexyl)phthalate	670	U	330	U	10	U	330	U	330	U	10	U
Di-n-octylphthalate	670	U	330	U	10	U	330	U	330	U	10	U
Benzo(b)fluoranthene	670	U	330	U	10	U	330	U	330	U	10	U
Benzo(k)fluoranthene	670	U	330	U	10	U	330	U	330	U	10	U
Benzo(a)pyrene	670	U	330	U	10	U	330	U	330	U	10	U
Indeno(1,2,3-cd)pyrene	670	U	330	U	10	U	330	U	330	U	10	U
Dibenz(a,h)anthracene	670	U	330	U	10	U	330	U	330	U	10	U
Benzo(g,h,i)perylene	670	U	330	U	10	U	330	U	330	U	10	U

(1) - Cannot be separated from Diphenylamine. *= Outside of Advisory limits.

Roy F. Weston, Inc. Stockton Laboratory

Semivolatiles by GC/MS, HSL List

RFW Batch Number: 93SE1810 Client: LAB Work Order: NONE Report Date: 03/04/93 14:11 Page: 2a

MAR 0 9 1993

	Cust ID:	JCF-01		JCF-02		JCF-03		JCF-04		JCF-05		JCF-05	
Sample Information	RFW#:	099-001		099-002		099-003		099-004		099-005		099-005 DL	
	Matrix:	SEDIMENT		SEDIMENT		SOIL		WATER		WATER		WATER	
	D.F.:	2.00		2.00		1.00		4.00		4.00		100	
	Units:	ug/Kg		ug/Kg		ug/Kg		ug/L		ug/l		ug/l	
Surrogate Recovery	Nitrobenzene-d5	89	%	90	%	87	%	97	%	69	%	D	%
	2-Fluorobiphenyl	103	%	101	%	91	%	108	%	103	%	D	%
	Terphenyl-d14	97	%	98	%	98	%	139	%	117	%	D	%
	Phenol-d5	97	%	95	%	85	%	53	%	20	%	D	%
	2-Fluorophenol	75	%	78	%	70	%	61	%	22	%	86	%
	2,4,6-Tribromophenol	86	%	93	%	81	%	87	%	62	%	102	%
			fl		fl		fl		fl		fl		fl
Phenol		1000	U	990	U	460	U	400	U	270	J	NA	
bis(2-Chloroethyl)ether		1000	U	990	U	460	U	400	U	400	U	NA	
2-Chlorophenol		1000	U	990	U	460	U	400	U	400	U	NA	
1,3-Dichlorobenzene		1000	U	990	U	460	U	400	U	400	U	NA	
1,4-Dichlorobenzene		1000	U	990	U	460	U	400	U	400	U	NA	
Benzyl alcohol		1000	U	990	U	460	U	400	U	400	U	NA	
1,2-Dichlorobenzene		1000	U	990	U	460	U	400	U	400	U	NA	
2-Methylphenol		1000	U	990	U	460	U	400	U	400	U	NA	
bis(2-Chloroisopropyl)ether		1000	U	990	U	460	U	400	U	400	U	NA	
4-Methylphenol		1000	U	990	U	460	U	400	U	400	U	NA	
N-Nitroso-di-n-propylamine		1000	U	990	U	460	U	400	U	400	U	NA	
Hexachloroethane		1000	U	990	U	460	U	400	U	400	U	NA	
Nitrobenzene		1000	U	990	U	460	U	400	U	400	U	NA	
Isophorone		1000	U	990	U	460	U	400	U	400	U	NA	
2-Nitrophenol		1000	U	990	U	460	U	400	U	400	U	NA	
2,4-Dimethylphenol		1000	U	990	U	460	U	400	U	400	U	NA	
Benzoic acid		5000	U	4900	U	2300	U	2000	U	1100	J	2600	
bis(2-Chloroethoxy)methane		1000	U	990	U	460	U	400	U	400	U	NA	
2,4-Dichlorophenol		1000	U	990	U	460	U	400	U	400	U	NA	
1,2,4-Trichlorobenzene		1000	U	990	U	460	U	400	U	400	U	NA	
Naphthalene		1000	U	990	U	460	U	350	J	400	U	NA	
4-Chloroaniline		1000	U	990	U	460	U	400	U	400	U	NA	
Hexachlorobutadiene		1000	U	990	U	460	U	400	U	400	U	NA	
4-Chloro-3-methylphenol		1000	U	990	U	460	U	400	U	400	U	NA	
2-Methylnaphthalene		1000	U	990	U	460	U	350	J	400	U	NA	
Hexachlorocyclopentadiene		1000	U	990	U	460	U	400	U	400	U	NA	

*= Outside of Advisory limits.

RFW Bat Number: 93SE1810 Client: LAB Work Order: NONE P . 2b

Cust ID:	JCF-01		JCF-02		JCF-03		JCF-04		JCF-05		JCr-05
RFW#:	099-001		099-002		099-003		099-004		099-005		099-005 DL
2,4,6-Trichlorophenol	1000	U	990	U	460	U	400	U	400	U	NA
2,4,5-Trichlorophenol	5000	U	4900	U	2300	U	2000	U	2000	U	NA
2-Chloronaphthalene	1000	U	990	U	460	U	400	U	400	U	NA
2-Nitroaniline	5000	U	4900	U	2300	U	2000	U	2000	U	NA
Dimethylphthalate	1000	U	990	U	460	U	400	U	400	U	NA
Acenaphthylene	1000	U	990	U	460	U	400	U	400	U	NA
2,6-Dinitrotoluene	1000	U	990	U	460	U	400	U	400	U	NA
3-Nitroaniline	5000	U	4900	U	2300	U	2000	U	2000	U	NA
Acenaphthene	1000	U	990	U	460	U	400	U	400	U	NA
2,4-Dinitrophenol	5000	U	4900	U	2300	U	2000	U	2000	U	NA
4-Nitrophenol	5000	U	4900	U	2300	U	2000	U	2000	U	NA
Dibenzofuran	1000	U	990	U	460	U	400	U	400	U	NA
2,4-Dinitrotoluene	1000	U	990	U	460	U	400	U	400	U	NA
Diethylphthalate	1000	U	990	U	460	U	400	U	400	U	NA
4-Chlorophenyl-phenylether	1000	U	990	U	460	U	400	U	400	U	NA
Fluorene	1000	U	990	U	460	U	400	U	400	U	NA
4-Nitroaniline	5000	U	4900	U	2300	U	2000	U	2000	U	NA
4,6-Dinitro-2-methylphenol	5000	U	4900	U	2300	U	2000	U	2000	U	NA
N-Nitrosodiphenylamine (1)	1000	U	990	U	460	U	400	U	400	U	NA
4-Bromophenyl-phenylether	1000	U	990	U	460	U	400	U	400	U	NA
Hexachlorobenzene	1000	U	990	U	460	U	400	U	400	U	NA
Pentachlorophenol	5000	U	4900	U	2300	U	2000	U	2000	U	NA
Phenanthrene	1000	U	990	U	100	J	200	J	400	U	NA
Anthracene	1000	U	990	U	460	U	400	U	400	U	NA
Di-n-butylphthalate	1000	U	990	U	460	U	400	U	400	U	NA
Fluoranthene	1000	U	990	U	110	J	400	U	400	U	NA
Pyrene	1000	U	990	U	110	J	400	U	400	U	NA
Butylbenzylphthalate	1000	U	990	U	460	U	400	U	400	U	NA
3,3'-Dichlorobenzidine	2000	U	2000	U	920	U	800	U	800	U	NA
Benzo(a)anthracene	1000	U	990	U	460	U	400	U	400	U	NA
Chrysene	1000	U	990	U	460	U	400	U	400	U	NA
bis(2-Ethylhexyl)phthalate	1000	U	990	U	280	J	310	J	400	U	NA
Di-n-octylphthalate	1000	U	990	U	460	U	400	U	400	U	NA
Benzo(b)fluoranthene	1000	U	990	U	460	U	400	U	400	U	NA
Benzo(k)fluoranthene	1000	U	990	U	460	U	400	U	400	U	NA
Benzo(a)pyrene	1000	U	990	U	460	U	400	U	400	U	NA
Indeno(1,2,3-cd)pyrene	1000	U	990	U	460	U	400	U	400	U	NA
Dibenz(a,h)anthracene	1000	U	990	U	460	U	400	U	400	U	NA
Benzo(g,h,i)perylene	1000	U	990	U	51	J	400	U	400	U	NA

(1) - Cannot be separated from Diphenylamine. *= Outside of Advisory limits.

MAR 0 9 1993

Roy F. Weston, Inc. Stockton Laboratory

Semivolatiles by GC/MS, HSL List

Report Date: 03/04/93 13:52

RFW Batch Number: 93025099 Client: JEFFERSON FOREST DRUM ST Work Order: 00000-000-000-0 Page: 1a

MAR 09 1993

Sample Information					
Cust ID:	JCF-06	JCF-06	JCF-05/OIL	JCF-05/OIL	SBLK1850
RFW#:	006	006 DL	099-007	099-007 DL	93SE1850-MB1
Matrix:	OIL	OIL	OIL	OIL	SOIL
D.F.:	20.0	100	20.0	100	10.0
Units:	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg

Phenol	200000	U	NA		200000	U	NA		100000	U
bis(2-Chloroethyl)ether	200000	U	NA		200000	U	NA		100000	U
2-Chlorophenol	200000	U	NA		200000	U	NA		100000	U
1,3-Dichlorobenzene	200000	U	NA		200000	U	NA		100000	U
1,4-Dichlorobenzene	200000	U	NA		200000	U	NA		100000	U
Benzyl alcohol	200000	U	NA		200000	U	NA		100000	U
1,2-Dichlorobenzene	200000	U	NA		200000	U	NA		100000	U
2-Methylphenol	200000	U	NA		200000	U	NA		100000	U
bis(2-Chloroisopropyl)ether	200000	U	NA		200000	U	NA		100000	U
4-Methylphenol	200000	U	NA		200000	U	NA		100000	U
N-Nitroso-di-n-propylamine	200000	U	NA		200000	U	NA		100000	U
Hexachloroethane	200000	U	NA		200000	U	NA		100000	U
Nitrobenzene	200000	U	NA		200000	U	NA		100000	U
Isophorone	200000	U	NA		200000	U	NA		100000	U
2-Nitrophenol	200000	U	NA		200000	U	NA		100000	U
2,4-Dimethylphenol	200000	U	NA		200000	U	NA		100000	U
Benzoic acid	1000000	U	NA		1000000	U	NA		500000	U
bis(2-Chloroethoxy)methane	200000	U	NA		200000	U	NA		100000	U
2,4-Dichlorophenol	200000	U	NA		200000	U	NA		100000	U
1,2,4-Trichlorobenzene	200000	U	NA		200000	U	NA		100000	U
Naphthalene	200000	U	NA		200000	U	NA		100000	U
4-Chloroaniline	200000	U	NA		200000	U	NA		100000	U
Hexachlorobutadiene	200000	U	NA		200000	U	NA		100000	U
4-Chloro-3-methylphenol	200000	U	NA		200000	U	NA		100000	U
2-Methylnaphthalene	200000	U	NA		200000	U	NA		100000	U
Hexachlorocyclopentadiene	200000	U	NA		200000	U	NA		100000	U
2,4,6-Trichlorophenol	200000	U	NA		200000	U	NA		100000	U
2,4,5-Trichlorophenol	1000000	U	NA		1000000	U	NA		500000	U
2-Chloronaphthalene	200000	U	NA		200000	U	NA		100000	U
2-Nitroaniline	1000000	U	NA		1000000	U	NA		500000	U
Dimethylphthalate	200000	U	NA		200000	U	NA		100000	U
Acenaphthylene	200000	U	NA		200000	U	NA		100000	U

*= Outside of Advisory limits.

RFW Ba' Number: 9302S099 Client: JEFFERSON FORE DRUM ST Work Order: 00000-000-000-0 P : 1b

Cust ID:	JCF-06		JCF-06		JCF-05/OIL		JCF-05/OIL		SBLK1850	
RFW#	006		006 DL		099-007		099-007 DL		93SE1850-MB1	
2,6-Dinitrotoluene	200000	U	NA		200000	U	NA		100000	U
3-Nitroaniline	1000000	U	NA		1000000	U	NA		500000	U
Acenaphthene	200000	U	NA		200000	U	NA		100000	U
2,4-Dinitrophenol	1000000	U	NA		1000000	U	NA		500000	U
4-Nitrophenol	1000000	U	NA		1000000	U	NA		500000	U
Dibenzofuran	200000	U	NA		200000	U	NA		100000	U
2,4-Dinitrotoluene	200000	U	NA		200000	U	NA		100000	U
Diethylphthalate	200000	U	NA		200000	U	NA		100000	U
4-Chlorophenyl-phenylether	200000	U	NA		200000	U	NA		100000	U
Fluorene	200000	U	NA		200000	U	NA		100000	U
4-Nitroaniline	1000000	U	NA		1000000	U	NA		500000	U
4,6-Dinitro-2-methylphenol	1000000	U	NA		1000000	U	NA		500000	U
N-Nitrosodiphenylamine (1)	200000	U	NA		200000	U	NA		100000	U
4-Bromophenyl-phenylether	200000	U	NA		200000	U	NA		100000	U
Hexachlorobenzene	200000	U	NA		200000	U	NA		100000	U
Pentachlorophenol	1000000	U	NA		1000000	U	NA		500000	U
Phenanthrene	200000	U	NA		200000	U	NA		100000	U
Anthracene	200000	U	NA		200000	U	NA		100000	U
Di-n-butylphthalate	200000	U	NA		200000	U	NA		100000	U
Fluoranthene	200000	U	NA		200000	U	NA		100000	U
Pyrene	200000	U	NA		200000	U	NA		100000	U
Butylbenzylphthalate	200000	U	NA		200000	U	NA		100000	U
3,3'-Dichlorobenzidine	400000	U	NA		400000	U	NA		200000	U
Benzo(a)anthracene	200000	U	NA		200000	U	NA		100000	U
Chrysene	200000	U	NA		200000	U	NA		100000	U
bis(2-Ethylhexyl)phthalate	200000	U	NA		200000	U	NA		100000	U
Di-n-octylphthalate	200000	U	NA		200000	U	NA		100000	U
Benzo(b)fluoranthene	200000	U	NA		200000	U	NA		100000	U
Benzo(k)fluoranthene	200000	U	NA		200000	U	NA		100000	U
Benzo(a)pyrene	200000	U	NA		200000	U	NA		100000	U
Indeno(1,2,3-cd)pyrene	200000	U	NA		200000	U	NA		100000	U
Dibenz(a,h)anthracene	200000	U	NA		200000	U	NA		100000	U
Benzo(g,h,i)perylene	200000	U	NA		200000	U	NA		100000	U

(1) - Cannot be separated from Diphenylamine. *= Outside of Advisory limits.

MAR 0 9 1993

ROY F. WESTON, INC.
STOCKTON LABORATORY
INORGANIC CASE NARRATIVE

Client: Jefferson Forest Drum ST
RFW#: 9302S099

W.O.#: 00000-000-000-0000-00
Date Rec'd: 02/12/93

Inorganics Case Narrative

1. Analyses completed in accordance with method 9010 with any exceptions noted below.

2. The analytical holding time for these analyses was met.

3. Calibration criteria was met for these analyses.

4. The method blank associated with these samples did not contain any target analyte at, or above, the reporting limits.

5. Blank spike recoveries were within Laboratory QC limits.

T. L. Hammonds
Inorganic Section Manager

February 25, 1993
Date

WESTON

MAR 0 9 1993

Roy F. Weston, Inc. - Stockton Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
JCF-01						
% SOLIDS	001	SE	93STS517	02/10/93	02/19/93	02/19/93
TOTAL CYANIDE	001	SE	93SCN024	02/10/93	02/23/93	02/23/93
TOTAL CYANIDE	001 MS	SE	93SCN024	02/10/93	02/23/93	02/23/93
TOTAL CYANIDE	001 MSD	SE	93SCN024	02/10/93	02/23/93	02/23/93
JCF-02						
% SOLIDS	002	SE	93STS517	02/10/93	02/19/93	02/19/93
TOTAL CYANIDE	002	SE	93SCN024	02/10/93	02/23/93	02/23/93
JCF-03						
% SOLIDS	003	S	93STS520	02/10/93	02/23/93	02/23/93
% SOLIDS	003 REP	S	93STS520	02/10/93	02/23/93	02/23/93
TOTAL CYANIDE	003	S	93SCN024	02/10/93	02/23/93	02/23/93
JCF-04						
TOTAL CYANIDE	004	OI	93SCN024	02/10/93	02/23/93	02/23/93
TOTAL CYANIDE	004 MS	OI	93SCN024	02/10/93	02/23/93	02/23/93
TOTAL CYANIDE	004 MSD	OI	93SCN024	02/10/93	02/23/93	02/23/93
JCF-05						
TOTAL CYANIDE	005	OI	93SCN024	02/10/93	02/23/93	02/23/93
JCF-06						
TOTAL CYANIDE	006	OI	93SCN024	02/10/93	02/23/93	02/23/93

LAB QC:

% SOLIDS	MB1	W	93STS517	02/19/93	02/19/93	02/19/93
TOTAL CYANIDE	LC1 L	S	93SCN024	02/23/93	02/23/93	02/23/93
TOTAL CYANIDE	LC2 L	S	93SCN024	02/23/93	02/23/93	02/23/93
TOTAL CYANIDE	MB1	S	93SCN024	02/23/93	02/23/93	02/23/93
% SOLIDS	MB1	W	93STS520	02/23/93	02/23/93	02/23/93

ROY F. WESTON INC.

INORGANIC DATA SUMMARY REPORT 02/26/93

MAR 0 9 1993

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	RESULT	UNITS	REPORTING LIMIT
-001	JCF-01	% Solids	66.5	%	0.10
		Cyanide, Total	0.50 u	MG/KG	0.50
-002	JCF-02	% Solids	67.6	%	0.10
		Cyanide, Total	0.50 u	MG/KG	0.50
-003	JCF-03	% Solids	72.5	%	0.10
		Cyanide, Total	0.91	MG/KG	0.50
-004	JCF-04	Cyanide, Total	1.4	MG/KG	0.50
-005	JCF-05	Cyanide, Total	0.50 u	MG/KG	0.50
-006	JCF-06	Cyanide, Total	0.50 u	MG/KG	0.50

ROY F. WESTON INC.

INORGANIC METHOD BLANK DATA SUMMARY PAGE 02/26/93

MAR 0 9 1993

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	RESULT	UNITS	REPORTING LIMIT
BLANK10	93STS517-MB1	% Solids	0.10 u	%	0.10
BLANK10	93SCN024-MB1	Cyanide, Total	0.50 u	MG/KG	0.50
BLANK10	93STS520-MB1	% Solids	0.10 u	%	0.10

ROY F. WESTON INC.

INORGANIC ACCURACY REPORT 02/26/93

MAR 0 9 1993

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	INITIAL RESULT	SPIKED AMOUNT	%RECOV
-001	JCF-01	Cyanide, Total	4.6	0.50u	5.0	91.1
		Cyanide, Total MSD	5.0	0.50u	5.0	99.2
-004	JCF-04	Cyanide, Total	6.0	1.4	5.0	92.1
		Cyanide, Total MSD	5.8	1.4	5.0	88.1

ROY F. WESTON INC.

INORGANIC DUPLICATE SPIKE REPORT 02/26/93

MAR 0 9 1993

CLIENT: JEFFERSON FOREST DRUM ST

WESTON BATCH #: 9302S099

WORK ORDER: 00000-000-000-0000-00

SAMPLE	SITE ID	ANALYTE	SPIKE#1 %RECOV	SPIKE#2 %RECOV	%RPD
-001	JCF-01	Cyanide, Total	91.1	99.2	8.5
-004	JCF-04	Cyanide, Total	92.1	88.1	4.5
LCS20	93SCN024-LC2	Cyanide, Total LCS	98.7	99.2	0.51

ROY F. WESTON INC.

INORGANIC PRECISION REPORT 02/26/93

MAR 0 9 1993

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	INITIAL RESULT	REPLICATE	%RPD
-003REP	JCF-03	% Solids	72.5	73.4	1.2

ROY F. WESTON INC.

INORGANIC LABORATORY CONTROL STANDARDS REPORT 02/26/93

MAR 0 9 1993

SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	SPIKED AMOUNT	UNITS	%RECOV
LCS10	93SCN024-LC1	Cyanide, Total LCS	4.9	5.0	MG/KG	98.7
LCS20	93SCN024-LC2	Cyanide, Total LCS	5.0	5.0	MG/KG	99.2

WESTON

MAR 09 1993

ROY F. WESTON, INC.
STOCKTON LABORATORY
METALS CASE NARRATIVE

Client: Jefferson Forest Drum St
RFW#: 9302S099

W.O.#: 00000-000-000-0000-00
Date Rec'd: 02/12/93

1. This narrative covers the analysis of two sediment, one soil, and three oil samples for the following metals: Aluminum, Antimony, Arsenic, Barium, Beryllium, Calcium, Cadmium, Cobalt, Chromium, Copper, Iron, Lead, Mercury, Magnesium, Manganese, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, and Zinc.

2. The samples were prepared and analyzed in accordance with the following protocols: 6010, 7060, 7421, 7471, 7740, and 7841.

3. All analyses were performed within the required holding times.

4. All Initial and Continuing Calibration Verifications (ICV/CCV's) were within control limits.

5. All Initial and Continuing Calibration Blanks (ICB/CCB's) were within control limits.

6. All Preparation/Method Blanks were below Reporting Limits.

7. All ICP Interference Check Samples (ICSAB) were within control limits.

8. All Laboratory Control Samples (LCS) were within the 80-120% control limits (exceptions allowed for Ag and Sb).

9. All Serial Dilution percent differences were within the 90-110% control limit except for Aluminum, Calcium, Iron, Sodium, and Zinc.

10. All Matrix Spike recoveries were within the 75-125% control limits except for Arsenic, Antimony, Calcium, Chromium, Magnesium, Selenium, Thallium, and Zinc (exception allowed when sample concentration exceeds the spike added concentration by a factor of 4 or more).

    Matrix spike analyses not required for Ca, Mg, Na, and K.

WESTON

Metals Case Narrative
RFW#: 9302S099

11. All Duplicate analyses were within the 20% Relative Percent Difference (RPD) control limits for samples values greater than 5X Reporting Limit, or +/- the Reporting Limits for sample values less than 5X Reporting Limit except for Aluminum, Antimony, Arsenic, Calcium, Lead, and Magnesium.

12. Method of Standard Additions (MSA) analyses were not required.

T. L. Hammonds
Inorganic Section Manager

Date

Roy F. Weston, Inc. - Stockton Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
JCF-01						
SILVER, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
ALUMINUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
ARSENIC, TOTAL	001	SE	93S1370	02/10/93	02/18/93	02/22/93
BARIUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
BERYLLIUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
CALCIUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
CADMIUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
COBALT, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
CHROMIUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
COPPER, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
IRON, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
MERCURY, TOTAL	001	SE	93SHG316	02/10/93	02/25/93	02/26/93
MERCURY, TOTAL	001 MS	SE	93SHG316	02/10/93	02/25/93	02/26/93
MERCURY, TOTAL	001 MSD	SE	93SHG316	02/10/93	02/25/93	02/26/93
POTASSIUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
MAGNESIUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
MANGANESE, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
SODIUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
NICKEL, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
LEAD, TOTAL	001	SE	93S1370	02/10/93	02/18/93	02/22/93
ANTIMONY, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
SELENIUM, TOTAL	001	SE	93S1370	02/10/93	02/18/93	02/22/93
THALLIUM, TOTAL	001	SE	93S1370	02/10/93	02/18/93	02/22/93
VANADIUM, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
ZINC, TOTAL	001	SE	93S1369	02/10/93	02/18/93	02/24/93
JCF-02						
SILVER, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
ALUMINUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
ARSENIC, TOTAL	002	SE	93S1370	02/10/93	02/18/93	02/22/93
BARIUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
BERYLLIUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
CALCIUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
CADMIUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
COBALT, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
CHROMIUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93

Roy F. Weston, Inc. - Stockton Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
COPPER, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
IRON, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
MERCURY, TOTAL	002	SE	93SHG316	02/10/93	02/25/93	02/26/93
POTASSIUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
MAGNESIUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
MANGANESE, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
SODIUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
NICKEL, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
LEAD, TOTAL	002	SE	93S1370	02/10/93	02/18/93	02/22/93
ANTIMONY, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
SELENIUM, TOTAL	002	SE	93S1370	02/10/93	02/18/93	02/22/93
THALLIUM, TOTAL	002	SE	93S1370	02/10/93	02/18/93	02/22/93
VANADIUM, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
ZINC, TOTAL	002	SE	93S1369	02/10/93	02/18/93	02/24/93
JCF-03						
SILVER, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
SILVER, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
SILVER, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
ALUMINUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
ALUMINUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
ALUMINUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
ARSENIC, TOTAL	003	S	93S1370	02/10/93	02/18/93	02/22/93
ARSENIC, TOTAL	003 MS	S	93S1370	02/10/93	02/18/93	02/22/93
ARSENIC, TOTAL	003 MSD	S	93S1370	02/10/93	02/18/93	02/22/93
BARIUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
BARIUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
BARIUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
BERYLLIUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
BERYLLIUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
BERYLLIUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
CALCIUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
CALCIUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
CALCIUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
CADMIUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
CADMIUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
CADMIUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
COBALT, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
COBALT, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93

Roy F. Weston, Inc. - Stockton Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
COBALT, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
CHROMIUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
CHROMIUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
CHROMIUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
COPPER, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
COPPER, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
COPPER, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
IRON, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
IRON, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
IRON, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
MERCURY, TOTAL	003	S	93SHG316	02/10/93	02/25/93	02/26/93
POTASSIUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
POTASSIUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
POTASSIUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
MAGNESIUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
MAGNESIUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
MAGNESIUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
MANGANESE, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
MANGANESE, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
MANGANESE, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
SODIUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
SODIUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
SODIUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
NICKEL, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
NICKEL, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
NICKEL, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
LEAD, TOTAL	003	S	93S1370	02/10/93	02/18/93	02/22/93
LEAD, TOTAL	003 MS	S	93S1370	02/10/93	02/18/93	02/22/93
LEAD, TOTAL	003 MSD	S	93S1370	02/10/93	02/18/93	02/22/93
ANTIMONY, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
ANTIMONY, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
ANTIMONY, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
SELENIUM, TOTAL	003	S	93S1370	02/10/93	02/18/93	02/22/93
SELENIUM, TOTAL	003 MS	S	93S1370	02/10/93	02/18/93	02/22/93
SELENIUM, TOTAL	003 MSD	S	93S1370	02/10/93	02/18/93	02/22/93
THALLIUM, TOTAL	003	S	93S1370	02/10/93	02/18/93	02/22/93
THALLIUM, TOTAL	003 MS	S	93S1370	02/10/93	02/18/93	02/22/93
THALLIUM, TOTAL	003 MSD	S	93S1370	02/10/93	02/18/93	02/22/93
VANADIUM, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
VANADIUM, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93

Roy F. Weston, Inc. - Stockton Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
VANADIUM, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
ZINC, TOTAL	003	S	93S1369	02/10/93	02/18/93	02/24/93
ZINC, TOTAL	003 MS	S	93S1369	02/10/93	02/18/93	02/24/93
ZINC, TOTAL	003 MSD	S	93S1369	02/10/93	02/18/93	02/24/93
JCF-04						
SILVER, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
SILVER, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
SILVER, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
ALUMINUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
ALUMINUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
ALUMINUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
ARSENIC, TOTAL	004	OI	93S1367	02/10/93	02/17/93	02/18/93
BARIUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
BARIUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
BARIUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
BERYLLIUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
BERYLLIUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
BERYLLIUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
CALCIUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
CALCIUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
CALCIUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
CADMIUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/24/93
CADMIUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/24/93
CADMIUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/24/93
COBALT, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
COBALT, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
COBALT, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
CHROMIUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
CHROMIUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
CHROMIUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
COPPER, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
COPPER, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
COPPER, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
IRON, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/24/93
IRON, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/24/93
IRON, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/24/93
MERCURY, TOTAL	004	OI	93SHG316	02/10/93	02/25/93	02/26/93
POTASSIUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93

Roy F. Weston, Inc. - Stockton Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

MAR 0 9 1993

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
POTASSIUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
POTASSIUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
MAGNESIUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
MAGNESIUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
MAGNESIUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
MANGANESE, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
MANGANESE, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
MANGANESE, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
SODIUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
SODIUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
SODIUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
NICKEL, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
NICKEL, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
NICKEL, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
LEAD, TOTAL	004	OI	93S1367	02/10/93	02/17/93	02/18/92
ANTIMONY, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
ANTIMONY, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
ANTIMONY, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
SELENIUM, TOTAL	004	OI	93S1367	02/10/93	02/17/93	02/18/93
THALLIUM, TOTAL	004	OI	93S1367	02/10/93	02/17/93	02/18/93
VANADIUM, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
VANADIUM, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
VANADIUM, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
ZINC, TOTAL	004	OI	93S1366	02/10/93	02/17/93	02/23/93
ZINC, TOTAL	004 MS	OI	93S1366	02/10/93	02/17/93	02/23/93
ZINC, TOTAL	004 MSD	OI	93S1366	02/10/93	02/17/93	02/23/93
JCF-05						
SILVER, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
ALUMINUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
ARSENIC, TOTAL	005	OI	93S1367	02/10/93	02/17/93	02/18/93
BARIUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
BERYLLIUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
CALCIUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
CADMIUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/24/93
COBALT, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
CHROMIUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
COPPER, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
IRON, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/24/93

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Roy F. Weston, Inc. - Stockton Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
MERCURY, TOTAL	005	OI	93SHG316	02/10/93	02/25/93	02/26/93
POTASSIUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
MAGNESIUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
MANGANESE, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
SODIUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
NICKEL, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
LEAD, TOTAL	005	OI	93S1367	02/10/93	02/17/93	02/18/92
ANTIMONY, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
SELENIUM, TOTAL	005	OI	93S1367	02/10/93	02/17/93	02/18/93
THALLIUM, TOTAL	005	OI	93S1367	02/10/93	02/17/93	02/18/93
VANADIUM, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
ZINC, TOTAL	005	OI	93S1366	02/10/93	02/17/93	02/23/93
JCF-06						
SILVER, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
ALUMINUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
ARSENIC, TOTAL	006	OI	93S1367	02/10/93	02/17/93	02/18/93
ARSENIC, TOTAL	006 MS	OI	93S1367	02/10/93	02/17/93	02/18/93
ARSENIC, TOTAL	006 MSD	OI	93S1367	02/10/93	02/17/93	02/18/93
BARIUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
BERYLLIUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
CALCIUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
CADMIUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/24/93
COBALT, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
CHROMIUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
COPPER, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
IRON, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/24/93
MERCURY, TOTAL	006	OI	93SHG316	02/10/93	02/25/93	02/26/93
POTASSIUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
MAGNESIUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
MANGANESE, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
SODIUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
NICKEL, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
LEAD, TOTAL	006	OI	93S1367	02/10/93	02/17/93	02/18/92
LEAD, TOTAL	006 MS	OI	93S1367	02/10/93	02/17/93	02/18/92
LEAD, TOTAL	006 MSD	OI	93S1367	02/10/93	02/17/93	02/18/92
ANTIMONY, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
SELENIUM, TOTAL	006	OI	93S1367	02/10/93	02/17/93	02/18/93
SELENIUM, TOTAL	006 MS	OI	93S1367	02/10/93	02/17/93	02/18/93

Roy F. Weston, Inc. · Stockton Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

MAR 0 9 1993

DATE RECEIVED: 02/12/93

RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
SELENIUM, TOTAL	006 MSD	OI	93S1367	02/10/93	02/17/93	02/18/93
THALLIUM, TOTAL	006	OI	93S1367	02/10/93	02/17/93	02/18/93
THALLIUM, TOTAL	006 MS	OI	93S1367	02/10/93	02/17/93	02/18/93
THALLIUM, TOTAL	006 MSD	OI	93S1367	02/10/93	02/17/93	02/18/93
VANADIUM, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93
ZINC, TOTAL	006	OI	93S1366	02/10/93	02/17/93	02/23/93

LAB QC:

SILVER LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
ALUMINUM LABORTORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
BARIUM LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
BERYLLIUM LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
CALCIUM LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
CADMIUM LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
COBALT LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
CHROMIUM LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
COPPER LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
IRON LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
POTASSIUM LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
MAGNESIUM LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
MANGANESE LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
SODIUM LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
NICKEL LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
ANTIMONY LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
VANADIUM LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
ZINC LABORATORY	LC1 BS	S	93S1369	02/18/93	02/18/93	02/24/93
SILVER LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
ALUMINUM LABORTORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
BARIUM LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
BERYLLIUM LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
CALCIUM LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
CADMIUM LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
COBALT LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
CHROMIUM LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
COPPER LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
IRON LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
POTASSIUM LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
MAGNESIUM LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
MANGANESE LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93

Roy F. Weston, Inc. · Stockton Laboratory
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JEFFERSON FOREST DRUM ST

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DATE RECEIVED: 02/12/93

RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
SODIUM LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
NICKEL LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
ANTIMONY LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
VANADIUM LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
ZINC LABORATORY	LC2 BS	S	93S1369	02/18/93	02/18/93	02/24/93
SILVER, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
ALUMINUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
BARIUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
BERYLLIUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
CALCIUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
CADMIUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
COBALT, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
CHROMIUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
COPPER, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
IRON, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
POTASSIUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
MAGNESIUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
MANGANESE, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
SODIUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
NICKEL, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
ANTIMONY, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
VANADIUM, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
ZINC, TOTAL	MB1	S	93S1369	02/18/93	02/18/93	02/24/93
ARSENIC LABORATORY	LC1 BS	S	93S1370	02/18/93	02/18/93	02/22/93
LEAD LABORATORY	LC1 BS	S	93S1370	02/18/93	02/18/93	02/22/93
SELENIUM LABORATORY	LC1 BS	S	93S1370	02/18/93	02/18/93	02/22/93
THALLIUM LABORATORY	LC1 BS	S	93S1370	02/18/93	02/18/93	02/22/93
ARSENIC LABORATORY	LC2 BS	S	93S1370	02/18/93	02/18/93	02/22/93
LEAD LABORATORY	LC2 BS	S	93S1370	02/18/93	02/18/93	02/22/93
SELENIUM LABORATORY	LC2 BS	S	93S1370	02/18/93	02/18/93	02/22/93
THALLIUM LABORATORY	LC2 BS	S	93S1370	02/18/93	02/18/93	02/22/93
ARSENIC, TOTAL	MB1	S	93S1370	02/18/93	02/18/93	02/22/93
LEAD, TOTAL	MB1	S	93S1370	02/18/93	02/18/93	02/22/93
SELENIUM, TOTAL	MB1	S	93S1370	02/18/93	02/18/93	02/22/93
THALLIUM, TOTAL	MB1	S	93S1370	02/18/93	02/18/93	02/22/93
MERCURY LABORATORY	LC1 BS	S	93SHG316	02/25/93	02/25/93	02/26/93
MERCURY LABORATORY	LC2 BS	S	93SHG316	02/25/93	02/25/93	02/26/93
MERCURY, TOTAL	MB1	S	93SHG316	02/25/93	02/25/93	02/26/93
SILVER LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
ALUMINUM LABORTORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93

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Roy F. Weston, Inc. - Stockton Laboratory
INORGANIC ANALYTICAL DATA PACKAGE FOR
JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
BARIUM LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
BERYLLIUM LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
CALCIUM LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
CADMIUM LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/24/93
COBALT LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
CHROMIUM LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
COPPER LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
IRON LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/24/93
POTASSIUM LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
MAGNESIUM LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
MANGANESE LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
SODIUM LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
NICKEL LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
ANTIMONY LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
VANADIUM LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
ZINC LABORATORY	LC1 BS	S	93S1366	02/17/93	02/17/93	02/23/93
SILVER LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
ALUMINUM LABORTORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
BARIUM LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
BERYLLIUM LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
CALCIUM LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
CADMIUM LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/24/93
COBALT LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
CHROMIUM LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
COPPER LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
IRON LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/24/93
POTASSIUM LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
MAGNESIUM LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
MANGANESE LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
SODIUM LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
NICKEL LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
ANTIMONY LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
VANADIUM LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
ZINC LABORATORY	LC2 BS	S	93S1366	02/17/93	02/17/93	02/23/93
SILVER, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
ALUMINUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
BARIUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
BERYLLIUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
CALCIUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
CADMIUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/24/93

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JEFFERSON FOREST DRUM ST

DATE RECEIVED: 02/12/93 RFW LOT # :9302S099

CLIENT ID /ANALYSIS	RFW #	MTX	PREP #	COLLECTION	EXTR/PREP	ANALYSIS
COBALT, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
CHROMIUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
COPPER, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
IRON, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/24/93
POTASSIUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
MAGNESIUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
MANGANESE, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
SODIUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
NICKEL, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
ANTIMONY, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
VANADIUM, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
ZINC, TOTAL	MB1	S	93S1366	02/17/93	02/17/93	02/23/93
ARSENIC LABORATORY	LC1 BS	S	93S1367	02/17/93	02/17/93	02/18/93
LEAD LABORATORY	LC1 BS	S	93S1367	02/17/93	02/17/93	02/18/92
SELENIUM LABORATORY	LC1 BS	S	93S1367	02/17/93	02/17/93	02/18/93
THALLIUM LABORATORY	LC1 BS	S	93S1367	02/17/93	02/17/93	02/18/93
ARSENIC LABORATORY	LC2 BS	S	93S1367	02/17/93	02/17/93	02/18/93
LEAD LABORATORY	LC2 BS	S	93S1367	02/17/93	02/17/93	02/18/92
SELENIUM LABORATORY	LC2 BS	S	93S1367	02/17/93	02/17/93	02/18/93
THALLIUM LABORATORY	LC2 BS	S	93S1367	02/17/93	02/17/93	02/18/93
ARSENIC, TOTAL	MB1	S	93S1367	02/17/93	02/17/93	02/18/93
LEAD, TOTAL	MB1	S	93S1367	02/17/93	02/17/93	02/18/92
SELENIUM, TOTAL	MB1	S	93S1367	02/17/93	02/17/93	02/18/93
THALLIUM, TOTAL	MB1	S	93S1367	02/17/93	02/17/93	02/18/93

ROY F. WESTON INC.

INORGANIC DATA SUMMARY REPORT 03/01/93

MAR 0 9 1993

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	RESULT	UNITS	REPORTING LIMIT
-001	JCF-01	Silver, Total	1.5 u	MG/KG	1.5
		Aluminum, Total	11000	MG/KG	30.1
		Arsenic, Total	20.5	MG/KG	15.0
		Barium, Total	51.6	MG/KG	30.1
		Beryllium, Total	0.95	MG/KG	0.75
		Calcium, Total	834	MG/KG	752
		Cadmium, Total	0.75 u	MG/KG	0.75
		Cobalt, Total	29.8	MG/KG	7.5
		Chromium, Total	21.0	MG/KG	1.5
		Copper, Total	28.1	MG/KG	3.8
		Iron, Total	62200	MG/KG	15.0
		Mercury, Total	0.04	MG/KG	0.03
		Potassium, Total	1630	MG/KG	752
		Magnesium, Total	3010	MG/KG	752
		Manganese, Total	760	MG/KG	2.3
		Sodium, Total	752 u	MG/KG	752
		Nickel, Total	57.2	MG/KG	6.0
		Lead, Total	29.3	MG/KG	4.5
		Antimony, Total	9.0 u	MG/KG	9.0
		Selenium, Total	0.75 u	MG/KG	0.75
		Thallium, Total	1.5 u	MG/KG	1.5
		Vanadium, Total	35.9	MG/KG	7.5
		Zinc, Total	152	MG/KG	3.0

ROY F. WESTON INC.

INORGANIC DATA SUMMARY REPORT 03/01/93

MAR 0 9 1993

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	RESULT		UNITS	REPORTING LIMIT
-002	JCF-02	Silver, Total	1.5	u	MG/KG	1.5
		Aluminum, Total	8670		MG/KG	29.6
		Arsenic, Total	23.1		MG/KG	14.8
		Barium, Total	39.5		MG/KG	29.6
		Beryllium, Total	0.74		MG/KG	0.74
		Calcium, Total	753		MG/KG	740
		Cadmium, Total	0.74	u	MG/KG	0.74
		Cobalt, Total	26.4		MG/KG	7.4
		Chromium, Total	14.0		MG/KG	1.5
		Copper, Total	17.3		MG/KG	3.7
		Iron, Total	40700		MG/KG	14.8
		Mercury, Total	0.04		MG/KG	0.03
		Potassium, Total	1330		MG/KG	740
		Magnesium, Total	2650		MG/KG	740
		Manganese, Total	658		MG/KG	2.2
		Sodium, Total	740	u	MG/KG	740
		Nickel, Total	46.8		MG/KG	5.9
		Lead, Total	27.1		MG/KG	4.4
		Antimony, Total	8.9	u	MG/KG	8.9
		Selenium, Total	0.74	u	MG/KG	0.74
		Thallium, Total	1.5	u	MG/KG	1.5
		Vanadium, Total	24.9		MG/KG	7.4
		Zinc, Total	103		MG/KG	3.0

ROY F. WESTON INC.

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INORGANIC DATA SUMMARY REPORT 03/01/93

CLIENT: JEFFERSON FOREST DRUM ST
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WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	RESULT	UNITS	REPORTING LIMIT
-003	JCF-03	Silver, Total	1.4 u	MG/KG	1.4
		Aluminum, Total	17700	MG/KG	27.6
		Arsenic, Total	7.1	MG/KG	2.8
		Barium, Total	230	MG/KG	27.6
		Beryllium, Total	0.69 u	MG/KG	0.69
		Calcium, Total	8440	MG/KG	690
		Cadmium, Total	2.9	MG/KG	0.69
		Cobalt, Total	10.8	MG/KG	6.9
		Chromium, Total	48.2	MG/KG	1.4
		Copper, Total	157	MG/KG	3.4
		Iron, Total	41400	MG/KG	13.8
		Mercury, Total	0.39	MG/KG	0.14
		Potassium, Total	1720	MG/KG	690
		Magnesium, Total	3400	MG/KG	690
		Manganese, Total	480	MG/KG	2.1
		Sodium, Total	1440	MG/KG	690
		Nickel, Total	38.9	MG/KG	5.5
		Lead, Total	1730	MG/KG	276
		Antimony, Total	15.4	MG/KG	8.3
		Selenium, Total	0.69 u	MG/KG	0.69
		Thallium, Total	1.4 u	MG/KG	1.4
		Vanadium, Total	27.3	MG/KG	6.9
		Zinc, Total	1220	MG/KG	2.8

ROY F. WESTON INC.

INORGANIC DATA SUMMARY REPORT 03/01/93

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CLIENT: JEFFERSON FOREST DRUM ST
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SAMPLE	SITE ID	ANALYTE	RESULT		UNITS	REPORTING LIMIT
-004	JCF-04	Silver, Total	1.0	u	MG/KG	1.0
		Aluminum, Total	92.4		MG/KG	20.0
		Arsenic, Total	1.5		MG/KG	1.0
		Barium, Total	25.3		MG/KG	20.0
		Beryllium, Total	0.50	u	MG/KG	0.50
		Calcium, Total	500	u	MG/KG	500
		Cadmium, Total	0.71		MG/KG	0.50
		Cobalt, Total	5.0	u	MG/KG	5.0
		Chromium, Total	3.5		MG/KG	1.0
		Copper, Total	2.5	u	MG/KG	2.5
		Iron, Total	1300		MG/KG	10.0
		Mercury, Total	0.04		MG/KG	0.02
		Potassium, Total	500	u	MG/KG	500
		Magnesium, Total	500	u	MG/KG	500
		Manganese, Total	7.9		MG/KG	1.5
		Sodium, Total	3020		MG/KG	500
		Nickel, Total	4.0	u	MG/KG	4.0
		Lead, Total	48.6		MG/KG	3.0
		Antimony, Total	6.0	u	MG/KG	6.0
		Selenium, Total	0.50	u	MG/KG	0.50
		Thallium, Total	1.0	u	MG/KG	1.0
		Vanadium, Total	5.0	u	MG/KG	5.0
		Zinc, Total	30.1		MG/KG	2.0

ROY F. WESTON INC.

INORGANIC DATA SUMMARY REPORT 03/01/93

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CLIENT: JEFFERSON FOREST DRUM ST
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WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	RESULT		UNITS	REPORTING LIMIT
-005	JCF-05	Silver, Total	1.0	u	MG/KG	1.0
		Aluminum, Total	20.3		MG/KG	20.0
		Arsenic, Total	99.2		MG/KG	20.0
		Barium, Total	25.9		MG/KG	20.0
		Beryllium, Total	0.50	u	MG/KG	0.50
		Calcium, Total	500	u	MG/KG	500
		Cadmium, Total	0.50	u	MG/KG	0.50
		Cobalt, Total	5.0	u	MG/KG	5.0
		Chromium, Total	1.3		MG/KG	1.0
		Copper, Total	2.5	u	MG/KG	2.5
		Iron, Total	95.3		MG/KG	10.0
		Mercury, Total	0.02	u	MG/KG	0.02
		Potassium, Total	4550		MG/KG	500
		Magnesium, Total	500	u	MG/KG	500
		Manganese, Total	1.9		MG/KG	1.5
		Sodium, Total	500	u	MG/KG	500
		Nickel, Total	4.0	u	MG/KG	4.0
		Lead, Total	1.4		MG/KG	0.30
		Antimony, Total	6.0	u	MG/KG	6.0
		Selenium, Total	0.50	u	MG/KG	0.50
		Thallium, Total	1.0	u	MG/KG	1.0
		Vanadium, Total	5.0	u	MG/KG	5.0
		Zinc, Total	131		MG/KG	2.0

ROY F. WESTON INC.

INORGANIC DATA SUMMARY REPORT 03/01/93

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CLIENT: JEFFERSON FOREST DRUM ST
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WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	RESULT		UNITS	REPORTING LIMIT
-006	JCF-06	Silver, Total	1.0	u	MG/KG	1.0
		Aluminum, Total	20.0	u	MG/KG	20.0
		Arsenic, Total	1.0	u	MG/KG	1.0
		Barium, Total	134		MG/KG	20.0
		Beryllium, Total	0.50	u	MG/KG	0.50
		Calcium, Total	500	u	MG/KG	500
		Cadmium, Total	0.50	u	MG/KG	0.50
		Cobalt, Total	5.0	u	MG/KG	5.0
		Chromium, Total	1.0	u	MG/KG	1.0
		Copper, Total	2.5	u	MG/KG	2.5
		Iron, Total	48.0		MG/KG	10.0
		Mercury, Total	0.02	u	MG/KG	0.02
		Potassium, Total	500	u	MG/KG	500
		Magnesium, Total	500	u	MG/KG	500
		Manganese, Total	1.5	u	MG/KG	1.5
		Sodium, Total	500	u	MG/KG	500
		Nickel, Total	4.0	u	MG/KG	4.0
		Lead, Total	12.6		MG/KG	1.5
		Antimony, Total	6.0	u	MG/KG	6.0
		Selenium, Total	0.50	u	MG/KG	0.50
		Thallium, Total	1.0	u	MG/KG	1.0
		Vanadium, Total	5.0	u	MG/KG	5.0
		Zinc, Total	223		MG/KG	2.0

ROY F. WESTON INC.

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INORGANIC METHOD BLANK DATA SUMMARY PAGE 03/01/93

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	RESULT		UNITS	REPORTING LIMIT
BLANK1	93S1369-MB1	Silver, Total	1.0	u	MG/KG	1.0
		Aluminum, Total	20.0	u	MG/KG	20.0
		Barium, Total	20.0	u	MG/KG	20.0
		Beryllium, Total	0.50	u	MG/KG	0.50
		Calcium, Total	500	u	MG/KG	500
		Cadmium, Total	0.50	u	MG/KG	0.50
		Cobalt, Total	5.0	u	MG/KG	5.0
		Chromium, Total	1.0	u	MG/KG	1.0
		Copper, Total	2.5	u	MG/KG	2.5
		Iron, Total	10.0	u	MG/KG	10.0
		Potassium, Total	500	u	MG/KG	500
		Magnesium, Total	500	u	MG/KG	500
		Manganese, Total	1.5	u	MG/KG	1.5
		Sodium, Total	500	u	MG/KG	500
		Nickel, Total	4.0	u	MG/KG	4.0
		Antimony, Total	6.0	u	MG/KG	6.0
		Vanadium, Total	5.0	u	MG/KG	5.0
		Zinc, Total	2.0	u	MG/KG	2.0
BLANK1	93S1370-MB1	Arsenic, Total	1.0	u	MG/KG	1.0
		Lead, Total	0.30	u	MG/KG	0.30
		Selenium, Total	0.50	u	MG/KG	0.50
		Thallium, Total	1.0	u	MG/KG	1.0
BLANK10	93SHG316-MB1	Mercury, Total	0.02	u	MG/KG	0.02
BLANK1	93S1366-MB1	Silver, Total	1.0	u	MG/KG	1.0
		Aluminum, Total	20.0	u	MG/KG	20.0
		Barium, Total	20.0	u	MG/KG	20.0
		Beryllium, Total	0.50	u	MG/KG	0.50
		Calcium, Total	500	u	MG/KG	500
		Cadmium, Total	0.50	u	MG/KG	0.50
		Cobalt, Total	5.0	u	MG/KG	5.0
		Chromium, Total	1.0	u	MG/KG	1.0
		Copper, Total	2.5	u	MG/KG	2.5
		Iron, Total	10.0	u	MG/KG	10.0
		Potassium, Total	500	u	MG/KG	500
		Magnesium, Total	500	u	MG/KG	500
		Manganese, Total	1.5	u	MG/KG	1.5
		Sodium, Total	500	u	MG/KG	500

ROY F. WESTON INC.

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INORGANIC METHOD BLANK DATA SUMMARY PAGE 03/01/93

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	RESULT		UNITS	REPORTING LIMIT
BLANK1	93S1366-MB1	Nickel, Total	4.0	u	MG/KG	4.0
		Antimony, Total	6.0	u	MG/KG	6.0
		Vanadium, Total	5.0	u	MG/KG	5.0
		Zinc, Total	2.0	u	MG/KG	2.0
BLANK1	93S1367-MB1	Arsenic, Total	1.0	u	MG/KG	1.0
		Lead, Total	0.30	u	MG/KG	0.30
		Selenium, Total	0.50	u	MG/KG	0.50
		Thallium, Total	1.0	u	MG/KG	1.0

ROY F. WESTON INC.

INORGANIC ACCURACY REPORT 03/01/93

MAR 0 9 1993

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	INITIAL RESULT	SPIKED AMOUNT	%RECOV
-001	JCF-01	Mercury, Total	0.22	0.04	0.15	121
		Mercury, Total MSD	0.20	0.04	0.15	112

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CLIENT: JEFFERSON FOREST DRUM ST
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SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	INITIAL RESULT	SPIKED AMOUNT	%RECOV	
-003	JCF-03	Silver, Total	7.0	1.4 u	6.9	101	
		Silver, Total MSD	7.4	1.4 u	6.9	107	
		Aluminum, Total	21300	17700	276	1290	*
		Aluminum, Total MSD	16600	17700	276	-390.	*
		Arsenic, Total	10.3	7.1	5.5	58.2	
		Arsenic, Total MSD	13.7	7.1	5.5	120	
		Barium, Total	461	230	276	84.1	
		Barium, Total MSD	528	230	276	108	
		Beryllium, Total	6.7	0.69u	6.9	97.1	
		Beryllium, Total MSD	6.5	0.69u	6.9	94.2	
		Calcium, Total	11900	8440	2760	124	*
		Calcium, Total MSD	45000	8440	2760	1330	*
		Cadmium, Total	9.2	2.9	6.9	91.3	
		Cadmium, Total MSD	8.3	2.9	6.9	78.3	
		Cobalt, Total	70.9	10.8	68.9	87.2	
		Cobalt, Total MSD	66.5	10.8	68.9	80.8	
		Chromium, Total	73.4	48.2	27.6	91.3	
		Chromium, Total MSD	60.0	48.2	27.6	42.8	
		Copper, Total	176	157	34.5	56.2	*
		Copper, Total MSD	209	157	34.5	151	*
		Iron, Total	48600	41400	138	5210	*
		Iron, Total MSD	32500	41400	138	6500.	*
		Potassium, Total	4160	1720	2760	88.2	
		Potassium, Total MSD	4190	1720	2760	89.4	
		Magnesium, Total	6020	3400	2760	95.0	
		Magnesium, Total MSD	10800	3400	2760	267	*
		Manganese, Total	500	480	68.9	27.9	*
		Manganese, Total MSD	430	480	68.9	-74.	*
		Sodium, Total	3890	1440	2760	88.8	
		Sodium, Total MSD	4250	1440	2760	102	
		Nickel, Total	110	38.9	68.9	104	
		Nickel, Total MSD	90.9	38.9	68.9	75.5	
		Lead, Total	1030	866	2.8	6010	*
		Lead, Total MSD	863	866	2.8	-96.	*
		Antimony, Total	41.2	15.4	68.9	37.4	
		Antimony, Total MSD	50.7	15.4	68.9	51.2	
		Selenium, Total	0.23	0.69u	1.4	16.4	
		Selenium, Total MSD	0.22	0.69u	1.4	15.7	
		Thallium, Total	6.5	1.4 u	6.9	94.2	
		Thallium, Total MSD	6.6	1.4 u	6.9	95.7	

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SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	INITIAL RESULT	SPIKED AMOUNT	%RECOV
-003	JCF-03	Vanadium, Total	89.7	27.3	68.9	90.6
		Vanadium, Total MSD	85.5	27.3	68.9	84.5
		Zinc, Total	1230	1220	68.9	20.0 *
		Zinc, Total MSD	1020	1220	68.9	-290. *

ROY F. WESTON INC.

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CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	INITIAL RESULT	SPIKED AMOUNT	%RECOV
-004	JCF-04	Silver, Total	4.8	1.0 u	5.0	96.0
		Silver, Total MSD	4.8	1.0 u	5.0	96.0
		Aluminum, Total	275	92.4	200	91.2
		Aluminum, Total MSD	278	92.4	200	92.6
		Barium, Total	204	25.3	200	89.6
		Barium, Total MSD	209	25.3	200	92.0
		Beryllium, Total	4.7	0.50u	5.0	94.0
		Beryllium, Total MSD	4.7	0.50u	5.0	94.0
		Calcium, Total	2160	500 u	2000	108
		Calcium, Total MSD	2210	500 u	2000	111
		Cadmium, Total	4.8	0.71	5.0	81.8
		Cadmium, Total MSD	5.0	0.71	5.0	85.8
		Cobalt, Total	46.5	5.0 u	50.0	93.0
		Cobalt, Total MSD	47.0	5.0 u	50.0	94.0
		Chromium, Total	22.0	3.5	20.0	92.5
		Chromium, Total MSD	21.9	3.5	20.0	92.0
		Copper, Total	25.3	2.5 u	25.0	101
		Copper, Total MSD	25.8	2.5 u	25.0	103
		Iron, Total	971	1300	100	-330. *
		Iron, Total MSD	1060	1300	100	-240. *
		Potassium, Total	2150	500 u	2000	108
		Potassium, Total MSD	2170	500 u	2000	109
		Magnesium, Total	1950	500 u	2000	97.5
		Magnesium, Total MSD	1980	500 u	2000	99.2
		Manganese, Total	51.9	7.9	50.0	88.0
		Manganese, Total MSD	53.1	7.9	50.0	90.4
		Sodium, Total	4840	3020	2000	90.9
		Sodium, Total MSD	4930	3020	2000	95.2
		Nickel, Total	46.9	4.0 u	50.0	93.8
		Nickel, Total MSD	46.7	4.0 u	50.0	93.4
		Antimony, Total	45.3	6.0 u	50.0	90.6
		Antimony, Total MSD	45.7	6.0 u	50.0	91.4
		Vanadium, Total	49.4	5.0 u	50.0	98.8
		Vanadium, Total MSD	50.0	5.0 u	50.0	100
		Zinc, Total	64.8	30.1	50.0	69.4
		Zinc, Total MSD	68.1	30.1	50.0	76.0

ROY F. WESTON INC.

INORGANIC ACCURACY REPORT 03/01/93

MAR 0 9 1993

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

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SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	INITIAL RESULT	SPIKED AMOUNT	%RECOV
-006	JCF-06	Arsenic, Total	3.6	1.0 u	4.0	90.0
		Arsenic, Total MSD	3.4	1.0 u	4.0	85.0
		Lead, Total	13.0	12.6	2.0	20.0 *
		Lead, Total MSD	14.9	12.6	2.0	115 *
		Selenium, Total	0.92	0.50u	1.0	92.0
		Selenium, Total MSD	0.90	0.50u	1.0	90.0
		Thallium, Total	3.4	1.0 u	5.0	68.0
		Thallium, Total MSD	4.2	1.0 u	5.0	84.0

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ROY F. WESTON INC.

INORGANIC DUPLICATE SPIKE REPORT 03/01/93

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	SPIKE#1 %RECOV	SPIKE#2 %RECOV	%RPD
-001	JCF-01	Mercury, Total	121	112	7.5

ROY F. WESTON INC.

INORGANIC DUPLICATE SPIKE REPORT 03/01/93

MAR 09 1993

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	SPIKE#1 %RECOV	SPIKE#2 %RECOV		%RPD
-003	JCF-03	Silver, Total	101	107		5.6
		Aluminum, Total	1290	-390.	*	NC
		Arsenic, Total	58.2	120		69.4
		Barium, Total	84.1	108		25.3
		Beryllium, Total	97.1	94.2		3.0
		Calcium, Total	124	1330		166
		Cadmium, Total	91.3	78.3		15.4
		Cobalt, Total	87.2	80.8		7.6
		Chromium, Total	91.3	42.8		72.4
		Copper, Total	56.2	151	*	NC
		Iron, Total	5210	6500.	*	NC
		Potassium, Total	88.2	89.4		1.4
		Magnesium, Total	95.0	267		95.0
		Manganese, Total	27.9	-74.	*	NC
		Sodium, Total	88.8	102		13.6
		Nickel, Total	104	75.5		31.4
		Lead, Total	6010	-96.	*	NC
		Antimony, Total	37.4	51.2		31.1
		Selenium, Total	16.4	15.7		4.4
		Thallium, Total	94.2	95.7		1.5
		Vanadium, Total	90.6	84.5		7.0
		Zinc, Total	20.0	-290.	*	NC

MAR 0 9 1993

ROY F. WESTON INC.

INORGANIC DUPLICATE SPIKE REPORT 03/01/93

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	SPIKE#1 %RECOV	SPIKE#2 %RECOV	%RPD
-004	JCF-04	Silver, Total	96.0	96.0	0.00
		Aluminum, Total	91.2	92.6	1.5
		Barium, Total	89.6	92.0	2.6
		Beryllium, Total	94.0	94.0	0.00
		Calcium, Total	108	111	2.3
		Cadmium, Total	81.8	85.8	4.8
		Cobalt, Total	93.0	94.0	1.1
		Chromium, Total	92.5	92.0	0.54
		Copper, Total	101	103	2.0
		Iron, Total	-330.	-240. *	NC
		Potassium, Total	108	109	0.97
		Magnesium, Total	97.5	99.2	1.7
		Manganese, Total	88.0	90.4	2.7
		Sodium, Total	90.9	95.2	4.7
		Nickel, Total	93.8	93.4	0.43
		Antimony, Total	90.6	91.4	0.88
		Vanadium, Total	98.8	100	1.2
		Zinc, Total	69.4	76.0	9.1

AR 0 9 1993

ROY F. WESTON INC.

INORGANIC DUPLICATE SPIKE REPORT 03/01/93

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	SPIKE#1 %RECOV	SPIKE#2 %RECOV	%RPD
-006	JCF-06	Arsenic, Total	90.0	85.0	5.7
		Lead, Total	20.0	115 *	NC
		Selenium, Total	92.0	90.0	2.2
		Thallium, Total	68.0	84.0	21.1
LCS2	93S1369-LC2	Silver, LCS	90.0	92.0	2.2
		Aluminum, LCS	99.4	96.6	2.8
		Barium, LCS	90.8	91.3	0.60
		Beryllium, LCS	88.0	88.0	0.00
		Calcium, LCS	94.9	94.5	0.41
		Cadmium, LCS	88.0	88.0	0.00
		Cobalt, LCS	88.6	88.4	0.23
		Chromium, LCS	92.0	91.0	1.1
		Copper, LCS	92.4	92.0	0.43
		Iron, LCS	92.1	92.1	0.00
		Potassium, LCS	93.8	91.8	2.1
		Magnesium, LCS	92.0	92.0	0.011
		Manganese, LCS	90.2	90.0	0.22
		Sodium, LCS	94.5	94.2	0.27
		Nickel, LCS	101	99.8	0.80
		Antimony, LCS	86.8	87.6	0.92
		Vanadium, LCS	92.0	92.0	0.00
		Zinc, LCS	88.0	87.6	0.46
LCS2	93S1370-LC2	Arsenic, LCS	102	102	0.00
		Lead, LCS	95.0	100	5.1
		Selenium, LCS	95.0	93.0	2.1
		Thallium, LCS	88.0	92.0	4.4
LCS20	93SHG316-LC2	Mercury, LCS	90.0	94.0	4.3
LCS2	93S1366-LC2	Silver, LCS	94.0	96.0	2.1
		Aluminum, LCS	99.4	102	2.6
		Barium, LCS	94.6	97.4	2.8
		Beryllium, LCS	92.0	94.0	2.2
		Calcium, LCS	97.9	99.8	2.0
		Cadmium, LCS	90.0	90.0	0.00
		Cobalt, LCS	92.8	94.6	1.9
		Chromium, LCS	102	100	2.5
		Copper, LCS	94.4	96.8	2.5
		Iron, LCS	94.5	94.2	0.32
		Potassium, LCS	96.6	98.7	2.2
		Magnesium, LCS	94.5	96.6	2.2
		Manganese, LCS	94.2	96.0	1.9

ROY F. WESTON INC.

MAR 0 9 1993

INORGANIC DUPLICATE SPIKE REPORT 03/01/93

CLIENT: JEFFERSON FOREST DRUM ST
WORK ORDER: 00000-000-000-0000-00

WESTON BATCH #: 9302S099

SAMPLE	SITE ID	ANALYTE	SPIKE#1 %RECOV	SPIKE#2 %RECOV	%RPD
LCS2	93S1366-LC2	Sodium, LCS	98.6	101	2.2
		Nickel, LCS	92.6	93.6	1.1
		Antimony, LCS	89.0	90.8	2.0
		Vanadium, LCS	98.6	101	2.2
		Zinc, LCS	90.8	93.0	2.4
LCS2	93S1367-LC2	Arsenic, LCS	90.0	92.5	2.7
		Lead, LCS	90.0	120	28.6
		Selenium, LCS	96.0	96.0	0.00
		Thallium, LCS	86.0	84.0	2.4

MAR 0 9 1993

ROY F. WESTON INC.

INORGANIC LABORATORY CONTROL STANDARDS REPORT 03/01/93

SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	SPIKED AMOUNT	UNITS	%RECOV
LCS1	93S1369-LC1	Silver, LCS	4.5	5.0	MG/KG	90.0
		Aluminum, LCS	199	200	MG/KG	99.4
		Barium, LCS	182	200	MG/KG	90.8
		Beryllium, LCS	4.4	5.0	MG/KG	88.0
		Calcium, LCS	1900	2000	MG/KG	94.9
		Cadmium, LCS	4.4	5.0	MG/KG	88.0
		Cobalt, LCS	44.3	50.0	MG/KG	88.6
		Chromium, LCS	18.4	20.0	MG/KG	92.0
		Copper, LCS	23.1	25.0	MG/KG	92.4
		Iron, LCS	92.1	100	MG/KG	92.1
		Potassium, LCS	1880	2000	MG/KG	93.8
		Magnesium, LCS	1840	2000	MG/KG	92.0
		Manganese, LCS	45.1	50.0	MG/KG	90.2
		Sodium, LCS	1890	2000	MG/KG	94.5
		Nickel, LCS	50.3	50.0	MG/KG	101
		Antimony, LCS	43.4	50.0	MG/KG	86.8
		Vanadium, LCS	46.0	50.0	MG/KG	92.0
		Zinc, LCS	44.0	50.0	MG/KG	88.0
LCS2	93S1369-LC2	Silver, LCS	4.6	5.0	MG/KG	92.0
		Aluminum, LCS	193	200	MG/KG	96.6
		Barium, LCS	183	200	MG/KG	91.3
		Beryllium, LCS	4.4	5.0	MG/KG	88.0
		Calcium, LCS	1890	2000	MG/KG	94.5
		Cadmium, LCS	4.4	5.0	MG/KG	88.0
		Cobalt, LCS	44.2	50.0	MG/KG	88.4
		Chromium, LCS	18.2	20.0	MG/KG	91.0
		Copper, LCS	23.0	25.0	MG/KG	92.0
		Iron, LCS	92.1	100	MG/KG	92.1
		Potassium, LCS	1840	2000	MG/KG	91.8
		Magnesium, LCS	1840	2000	MG/KG	92.0
		Manganese, LCS	45.0	50.0	MG/KG	90.0
		Sodium, LCS	1880	2000	MG/KG	94.2
		Nickel, LCS	49.9	50.0	MG/KG	99.8
		Antimony, LCS	43.8	50.0	MG/KG	87.6
		Vanadium, LCS	46.0	50.0	MG/KG	92.0
		Zinc, LCS	43.8	50.0	MG/KG	87.6
LCS1	93S1370-LC1	Arsenic, LCS	4.1	4.0	MG/KG	102
		Lead, LCS	1.9	2.0	MG/KG	95.0

ROY F. WESTON INC.

INORGANIC LABORATORY CONTROL STANDARDS REPORT 03/01/93

MAR 0 9 1993

SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	SPIKED AMOUNT	UNITS	%RECOV
LCS1	93S1370-LC1	Selenium, LCS	0.95	1.0	MG/KG	95.0
		Thallium, LCS	4.4	5.0	MG/KG	88.0
LCS2	93S1370-LC2	Arsenic, LCS	4.1	4.0	MG/KG	102
		Lead, LCS	2.0	2.0	MG/KG	100
		Selenium, LCS	0.93	1.0	MG/KG	93.0
		Thallium, LCS	4.6	5.0	MG/KG	92.0
LCS10	93SHG316-LC1	Mercury, LCS	0.09	0.1	MG/KG	90.0
LCS20	93SHG316-LC2	Mercury, LCS	0.09	0.1	MG/KG	94.0
LCS1	93S1366-LC1	Silver, LCS	4.7	5.0	MG/KG	94.0
		Aluminum, LCS	199	200	MG/KG	99.4
		Barium, LCS	189	200	MG/KG	94.6
		Beryllium, LCS	4.6	5.0	MG/KG	92.0
		Calcium, LCS	1960	2000	MG/KG	97.9
		Cadmium, LCS	4.5	5.0	MG/KG	90.0
		Cobalt, LCS	46.4	50.0	MG/KG	92.8
		Chromium, LCS	20.5	20.0	MG/KG	102
		Copper, LCS	23.6	25.0	MG/KG	94.4
		Iron, LCS	94.5	100	MG/KG	94.5
		Potassium, LCS	1930	2000	MG/KG	96.6
		Magnesium, LCS	1890	2000	MG/KG	94.5
		Manganese, LCS	47.1	50.0	MG/KG	94.2
		Sodium, LCS	1970	2000	MG/KG	98.6
		Nickel, LCS	46.3	50.0	MG/KG	92.6
		Antimony, LCS	44.5	50.0	MG/KG	89.0
		Vanadium, LCS	49.3	50.0	MG/KG	98.6
		Zinc, LCS	45.4	50.0	MG/KG	90.8
LCS2	93S1366-LC2	Silver, LCS	4.8	5.0	MG/KG	96.0
		Aluminum, LCS	204	200	MG/KG	102
		Barium, LCS	195	200	MG/KG	97.4
		Beryllium, LCS	4.7	5.0	MG/KG	94.0
		Calcium, LCS	2000	2000	MG/KG	99.8
		Cadmium, LCS	4.5	5.0	MG/KG	90.0
		Cobalt, LCS	47.3	50.0	MG/KG	94.6
		Chromium, LCS	20.0	20.0	MG/KG	100
		Copper, LCS	24.2	25.0	MG/KG	96.8

ROY F. WESTON INC.

INORGANIC LABORATORY CONTROL STANDARDS REPORT 03/01/93

MAR 0 9 1993

SAMPLE	SITE ID	ANALYTE	SPIKED SAMPLE	SPIKED AMOUNT	UNITS	%RECOV
LCS2	93S1366-LC2	Iron, LCS	94.2	100	MG/KG	94.2
		Potassium, LCS	1970	2000	MG/KG	98.7
		Magnesium, LCS	1930	2000	MG/KG	96.6
		Manganese, LCS	48.0	50.0	MG/KG	96.0
		Sodium, LCS	2020	2000	MG/KG	101
		Nickel, LCS	46.8	50.0	MG/KG	93.6
		Antimony, LCS	45.4	50.0	MG/KG	90.8
		Vanadium, LCS	50.4	50.0	MG/KG	101
		Zinc, LCS	46.5	50.0	MG/KG	93.0
LCS1	93S1367-LC1	Arsenic, LCS	3.6	4.0	MG/KG	90.0
		Lead, LCS	1.8	2.0	MG/KG	90.0
		Selenium, LCS	0.96	1.0	MG/KG	96.0
		Thallium, LCS	4.3	5.0	MG/KG	86.0
LCS2	93S1367-LC2	Arsenic, LCS	3.7	4.0	MG/KG	92.5
		Lead, LCS	2.4	2.0	MG/KG	120
		Selenium, LCS	0.96	1.0	MG/KG	96.0
		Thallium, LCS	4.2	5.0	MG/KG	84.0

Copy from G. Scogin's logbook "1

2/10/93

0915 Arrive @ A.L. Taylor site - walk to Jefferson Forest drum site. Met TATS John Maybrier and Matt Merka

Do site recon: observed ~ 20 empty, very old & weathered drums down in a ravine area ~~gulch~~ perhaps created by built up soil. The ravine area goes to a gradual slope with an intermittent creek about 20 ft from the embankment w/ of drums. There are indicies that the area floods from time to time

1000 Health & Safety meeting. Maybrier discussed plan of operation w/ Heritage (Subk) personnel

Plan: geo back soil from near embankment area first to determine the extent of drum burial. Then use that area to stage the empty drums encountered.

1201 departed site for lunch

1315 returned to site

1715 in order to assist the state or other party involved in future removal of solid waste materials, I arranged for subk to crush and stockpile empty drums in & stage them in an area of the embankment that appeared to b backfill.

The trackhoe was used to ~~g~~ dig ⊥ into the edge of the embankment ~ 6' in order to ~~determ~~ unearth any buried drums. The only drums found were the ones already exposed or partially exposed. A trench parallel to and on top of the ridge was dug to ~ 5' deep. Solid waste mat'l was exposed such as fiberglass insulation, PVC bags, and construction

for a small area that appeared to be fill dirt. The state contact, Lagwanda Maybrier indicated ~ 200 yds. away on a barren, mounded area where they had observed high readings fr a metal detector. The trackhoe was used to excavate a 6' deep trench in this area. Found no evidence of drums or other debris. The native soil has a high iron content & may explain the readings.

Three drums were found to contain some liquid material. Samples were collected. The drums were covered w/ Visqueen and taped. Upgradient downgradient sediment samples were collected. One of the sediment samples was duplicated for QA purposes. A sample of some ashy powdery mat'l that apparently spilled out of a ~~corroded~~ weathered, broken container was also

a total of seven samples collected

3 drums/liquids

2 sediments

1 duplicate

1 soil

Did not sample the paint solids found the debris.

Reference 13

Reference 14

Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States

By HANSFORD T. SHACKLETTE *and* JOSEPHINE G. BOERNGEN

U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1270

An account of the concentrations of 50 chemical elements in samples of soils and other regoliths

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1984

TABLE 1.—*Average or median contents, and range in contents, reported for elements in soils and other surficial materials*

[Data are in parts per million; each average represents arithmetic mean; leaders (—) in figure columns indicate no data available. A, average; M, median. <, less than; >, greater than]

Element	This report		Rose, and others (1979) (elements useful in geochemical prospecting)	Vinogradov (1959) (presumably, averages from worldwide sampling)	Jackson (1964)	Mitchell (1964)	Brooks (1972)
	Average	Range			"Typical",[1] average, or range in values	Range in contents in Scottish surface soils	Average or range
Al	72,000	700 - <10,000	—	71,300	10,000 - 60,000	—	—
As	7.2	<0.1 - 97	7.5 (M)	5	—	—	5
B	33	<20 - 300	29 (M)	10	30	—	10
Ba	580	10 - 5,000	300 (M)	—	—	400 - 3,000	500
Be	.92	<1 - 15	0.5 - 4	6	—	<5 - 5	6
Br	.85	<0.5 - 11	—	5	—	—	—
C, total	25,000	600 - 370,000	—	20,000	—	—	—
Ca	24,000	100 - 320,000	—	13,700	7,000	—	—
Ce	75	<150 - 300	—	—	—	—	—
Co	9.1	<3 - 70	10 (M)	8	—	<2 - 80	10
Cr	54	1 - 2,000	6.3 (M)	200	—	5 - 3,000	200
Cu	25	<1 - 700	15 (M)	20	20	<10 - 100	20
F	430	<10 - 3,700	300 (M)	200	—	—	—
Fe	26,000	100 - >100,000	21,000 (M)	38,000	7,000 - 42,000	—	10,000 - 50,000
Ga	17	<5 - 70	—	30	—	15 - 70	20
Ge	1.2	<0.1 - 2.5	—	1	—	—	5
Hg	.09	<0.01 - 4.6	0.056 (M)	—	—	—	.01
I	1.2	<0.5 - 9.6	—	—	—	—	—
K	15,000	50 - 63,000	11,000 (M)	13,600	400 - 28,000	—	—
La	37	<30 - 200	—	—	—	<30 - 200	—
Li	24	<5 - 140	6.2 (M)	30	—	—	30
Mg	9,000	50 - >100,000	—	6,300	<6,000	—	—
Mn	550	<2 - 7,000	320 (M)	850	—	200 - 5,000	850
Mo	.97	<3 - 15	2.5 (A)	2	—	<1 - 5	2.5
Na	12,000	<500 - 100,000	—	6,300	—	—	—
Nb	11	<10 - 100	15 (A)	—	—	—	15
Nd	46	<70 - 300	—	—	—	—	—
Ni	19	<5 - 700	17 (M)	40	—	10 - 800	40
P	430	<20 - 6,800	300 (M)	800	500	—	—
Pb	19	<10 - 700	17 (M)	—	—	<20 - 80	10
Rb	67	<20 - 210	35 (M)	100	—	—	—
S, total	1,600	<800 - 48,000	100 - 2,000	850	—	—	—
Sb	.66	<1 - 8.8	2 (A)	—	—	—	.5
Sc	8.9	<5 - 50	—	7	—	<3 - 15	—
Se	.39	<0.1 - 4.3	0.31 (M)	.001	—	—	.5
Si	310,000	16,000 - 450,000	—	330,000	—	—	—
Sm	1.3	<0.1 - 10	10 (A)	—	—	—	10
Sr	240	<5 - 3,000	67 (M)	300	—	60 - 700	300
Ti	2,900	70 - 20,000	—	4,600	1,200 - 6,000	—	—
Th	9.4	2.2 - 31	—	—	—	—	13
U	2.7	0.29 - 11	1 (A)	—	—	—	1
V	80	<7 - 500	57 (M)	100	—	20 - 250	100
Y	25	<10 - 200	—	50	—	25 - 100	—
Yb	3.1	<1 - 50	—	—	—	—	—
Zn	60	<5 - 2,900	36 (M)	50	—	—	50
Zr	230	<20 - 2,000	270 (M)	300	—	200 - >1,000	—

[1]Author's usage; generally used to indicate the most commonly occurring value.

collected by U.S. Geological Survey personnel along their routes of travel to areas of other types of field studies or within their project areas.

The locations of the routes that were sampled depended on both the network of roads that existed and the destinations of the samplers. Sampling intensity was kept at a minimum by selecting only one sampling site every 80 km (about 50 miles; selected for convenience because vehicle odometers were calibrated in miles) along the routes. The specific sampling sites were selected, insofar as possible, that had surficial materials that were very little altered from their natural condition and that supported native plants suitable for sampling. In practice, this site selection necessitated sampling away from roadcuts and fills. In some areas, only cultivated fields and plants were available for sampling.

Contamination of the sampling sites by vehicular emissions was seemingly insignificant, even though many sites were within 100 m or less of the roads. Col-

1, unlike the geometric means shown in table 2, are estimates of geochemical abundance (Miesch, 1967). Arithmetic means are always larger than corresponding geometric means (Miesch, 1967, p. B1) and are estimates of the fractional part of a single specimen that consists of the element of concern rather than of the typical concentration of the element in a suite of samples.

Concentrations of 46 elements in samples of this study are presented in table 2, which gives the determination ratios, geometric-mean concentrations and deviations, and observed ranges in concentrations. The analytical data for most elements as received from the laboratories were transformed into logarithms because of the tendency for elements in natural materials, particularly the trace elements, to have positively skewed

TABLE 2.—*Mean concentrations, deviations, and ranges of elements in samples of soils and other surficial materials in the conterminous United States*

[Means and ranges are reported in parts per million (μg/g), and means and deviations are geometric except as indicated. Ratio, number of samples in which the element was found in measurable concentrations to number of samples analyzed. <, less than; >, greater than]

Element	Conterminous United States			Western United States (west of 96th meridian)					Eastern United States (east of 96th meridian)				
	Mean	Deviation	Estimated arithmetic mean	Ratio	Mean	Deviation	Observed range	Estimated arithmetic mean	Ratio	Mean	Deviation	Observed range	Estimated arithmetic mean
Al, percent	4.7	2.48	7.2	661:770	5.8	2.00	0.5 - >10	7.4	450:477	3.3	2.87	0.7 - >10	5.7
As	5.2	2.23	7.2	728:730	5.5	1.98	<0.10 - 97	7.0	521:527	4.8	2.56	<0.1 - 73	7.4
B	26	1.97	33	506:778	23	1.99	<20 - 300	29	425:541	31	1.88	<20 - 150	38
Ba	440	2.14	580	778:778	580	1.72	70 - 5,000	670	541:541	290	2.35	10 - 1,500	420
Be	.63	2.38	.92	310:778	.68	2.30	<1 - 15	.97	169:525	.55	2.53	<1 - 7	.85
Bi	.56	2.50	.85	113:220	.52	2.74	<0.5 - 11	.86	78:128	.62	2.18	<0.5 - 5.3	.85
C, percent	1.6	2.57	2.5	250:250	1.7	2.37	0.16 - 10	2.5	162:162	1.5	2.88	0.06 - 37	2.6
Ca, percent	.92	4.00	2.4	777:777	1.8	3.05	0.06 - 32	3.3	514:514	.34	3.08	0.01 - 28	.63
Ce	63	1.78	73	81:683	65	1.71	<150 - 300	75	70:489	63	1.85	<150 - 300	76
Co	6.7	2.19	9.1	698:778	7.1	1.97	<3 - 50	9.0	403:533	5.9	2.57	<0.3 - 70	9.2
Cr	37	2.37	54	778:778	41	2.19	3 - 2,000	56	541:541	33	2.60	1 - 1,000	52
Cu	17	2.44	25	778:778	21	2.07	2 - 300	27	523:533	13	2.80	<1 - 700	22
F	210	3.34	430	598:610	280	2.52	<10 - 1,900	440	390:435	130	4.19	<10 - 3,700	360
Fe, percent	1.8	2.38	2.6	776:777	2.1	1.95	0.1 - >10	2.6	539:540	1.4	2.87	0.01 - >10	2.5
Ga	13	2.03	17	767:776	16	1.68	<5 - 70	19	431:540	9.3	2.38	<5 - 70	14
Ge	1.2	1.37	1.2	224:224	1.2	1.32	0.58 - 2.5	1.2	130:131	1.1	1.45	<0.1 - 2.0	1.2
Hg	.058	2.52	.089	729:733	.046	2.33	<0.01 - 4.6	.065	534:534	.081	2.52	0.01 - 3.4	.12
I	.75	2.63	1.2	169:246	.79	2.55	<0.5 - 9.6	1.2	90:153	.68	2.81	<0.5 - 7.0	1.2
K, percent[1]	1.5	.79	None	777:777	1.8	.71	0.19 - 6.3	None	537:537	1.2	.75	0.005 - 3.7	—
La	30	1.92	37	462:777	30	1.89	<30 - 200	37	294:516	29	1.98	<30 - 200	37
Li	20	1.85	24	731:731	22	1.58	5 - 130	25	479:527	17	2.16	<5 - 140	22
Mg, percent	.44	3.28	.90	777:778	.74	2.21	0.03 - >10	1.0	528:528	.21	3.55	0.005 - 5	.46
Mn	330	2.77	550	777:777	380	1.98	30 - 5,000	480	537:540	260	3.82	<2 - 7,000	640
Mo	.59	2.72	.97	57:774	.85	2.17	<3 - 7	1.1	32:524	.32	3.93	<3 - 15	.79
Na, percent	.59	3.27	1.2	744:744	.97	1.95	0.05 - 10	1.2	363:449	.25	4.55	<0.05 - 5	.78
Nb	9.3	1.75	11	418:771	8.7	1.82	<10 - 100	10	322:498	10	1.65	<10 - 50	12
Nd	40	1.68	46	120:538	36	1.76	<70 - 300	43	109:332	46	1.58	<70 - 300	51
Ni	13	2.31	19	747:778	15	2.10	<5 - 700	19	443:540	11	2.64	<5 - 700	18
P	260	2.67	430	524:524	320	2.33	40 - 4,500	460	380:382	200	2.95	<20 - 6,800	360
Pb	16	1.86	19	712:778	17	1.80	<10 - 700	20	422:541	14	1.95	<10 - 300	17
Rb	58	1.72	67	221:224	69	1.50	<20 - 210	74	107:131	43	1.94	<20 - 160	53
S, percent	.12	2.04	.16	34:224	.13	2.37	<0.08 - 4.8	.19	20:131	.10	1.34	<0.08 - 0.31	.11
Sb	.48	2.27	.67	35:223	.47	2.15	<1 - 2.6	.62	31:131	.52	2.38	<1 - 8.8	.76
Sc	7.5	1.82	8.9	685:778	8.2	1.74	<5 - 50	9.6	389:526	6.5	1.90	<5 - 30	8.0
Se	.26	2.46	.39	590:733	.23	2.43	<0.1 - 4.3	.34	449:534	.30	2.44	<0.1 - 3.9	.43
Si, percent[1]	31	6.48	None	250:250	30	5.70	15 - 44	None	156:156	34	6.64	1.7 - 45	—
Sn	.89	2.36	1.3	218:224	.90	2.11	<0.1 - 7.4	1.2	123:131	.86	2.81	<0.1 - 10	1.5
Sr	120	3.30	240	778:778	200	2.16	10 - 3,000	270	501:540	53	3.61	<5 - 700	120
Ti, percent	.24	1.89	.29	777:777	.22	1.78	0.05 - 2.0	.26	540:540	.28	2.00	0.007 - 1.5	.35
Th	8.6	1.53	9.4	195:195	9.1	1.49	2.4 - 31	9.8	102:102	7.7	1.58	2.2 - 23	8.6
U	2.3	1.73	2.7	224:224	2.5	1.45	0.68 - 7.9	2.7	130:130	2.1	2.12	0.29 - 11	2.7
V	58	2.25	80	778:778	70	1.95	7 - 500	88	516:541	43	2.51	<7 - 300	66
Y	21	1.78	25	759:778	22	1.66	<10 - 150	25	477:541	20	1.97	<10 - 200	25
Yb	2.6	1.79	3.1	754:764	2.6	1.63	<1 - 20	3.0	452:486	2.6	2.06	<1 - 50	3.3
Zn	48	1.95	60	766:766	55	1.79	10 - 2,100	65	473:482	40	2.11	<5 - 2,900	52
Zr	180	1.91	230	777:778	160	1.77	<20 - 1,300	190	539:541	220	2.01	<20 - 2,000	290

[1]Means are arithmetic, deviations are standard.

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Reference 15

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Waste Programs Enforcement
Washington, D.C. 20460

Contract No. [illegible]
Work Assignment No. [illegible]

EPA Work Assignment Manager
Larry A. Weiner, Headquarters
Shane Fitzsimonds, Region IX

FEASIBILITY STUDY ADDENDUM AND ENDANGERMENT ASSESSMENT

A. L. [illegible] SITE
[illegible], [illegible]

Final Report

~~INVESTIGATIVE DOCUMENT IN ANTICIPATION OF LITIGATION~~

ENFORCEMENT CONFIDENTIAL

November 1984

Prepared by

Metcalf & Eddy, Inc.
Boston, Massachusetts 02114

Under Subcontract to

GCA CORPORATION
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Bedford, Massachusetts 01730

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REPORT TO U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WASTE PROGRAMS ENFORCEMENT

FEASIBILITY STUDY ADDENDUM
and
ENDANGERMENT ASSESSMENT

A. L. TAYLOR SITE
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September 1984

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INTRODUCTION

The Feasibility Study Addendum is a supplemental document to Ecology and Environment, Inc.'s "Feasibility Study of Remedial Alternatives for the A. L. Taylor Site (September, 1982)". Metcalf & Eddy, Inc. was tasked by the U.S. Environmental Protection Agency to update the 1982 Feasibility Study according to National Contingency Plan under CERCLA (Section 1.06A) requirements. These requirements call in part for the evaluation of proposed remedial alternatives and an assessment of the threat which the site poses to public health, welfare and the environment (endangerment assessment).

The Addendum report consists of three chapters. Chapter 1 will describe all site response actions taken since the 1982 Feasibility Study (FS) report. These site response actions have consisted of site investigation reports, major site EPA actions, potential responsible party (PRP) actions, PRP consultant reports, and a proposal of an additional site remedial alternative.

Chapter 2 will cover Metcalf & Eddy's Endangerment Assessment for the A. L. Taylor Site. This Endangerment Assessment of the site (no action alternative) will include the following: a brief review of the site contamination problem; a discussion of the environmental fate and transport of the contaminants; an exposure evaluation; a description of the toxicological properties of the contaminants; a risk evaluation; and conclusions.

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The 1982 FS report evaluated three remedial alternatives (minimum action, on-site containment and waste excavation/-removal); however, a modified on-site containment alternative was proposed subsequent to the 1982 FS report. Chapter 3 of this Addendum report will, therefore, describe and evaluate the modified remedial alternative. This evaluation will cover a technical evaluation of the proposed alternative and its effect on the site hydrogeology. The evaluation will also include an assessment of the public health impacts and environmental impacts associated with implementation of the proposed modified on-site containment remedial alternative.

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CHAPTER 1

A.L. TAYLOR SITE RESPONSE ACTIONS UPDATE

Metcalf & Eddy, Inc. (M&E) has reviewed all the available documents regarding the A.L. Taylor Site which are listed in the REFERENCES section at the end of this report. This Chapter updates and summarizes response actions taken subsequent to the 1982 Feasibility Study for the site. The following major site reports will be summarized:

1. Ecology and Environment, Inc., 1982a, "A.L. Taylor Site Deep Test Boring," TDD No. F4-82-8-05, FIT Project Contract No. 68-01-6056, December 14 (Letter Report from Carol J. Thurmond to Jack Stonebraker).

2. NUS Corporation, 1983, "Sampling Investigation Report, A.L. Taylor Site, Brooks, Kentucky," EPA Contract No. 68-01-6699, TDD No. F4-8210-05 and F4-8303-04, August.

3. Geosciences Research Associates, Inc., 1983, "A.L. Taylor Site On-site Containment Plan," Letter Report from Robert E. Aten, September 28.

4. Tenech Environmental Engineers, Inc., 1983, "Final Design Report for the A.L. Taylor Hazardous Waste Disposal Site," September 30.

5. Metcalf & Eddy, Inc. 1983. Review of Data and Proposed Remedial Alternative for the A.L. Taylor Site, Brooks, Kentucky. Letter Report to Mr. Shane Hitchcock, U.S. Environmental Protection Agency, Region IV. Unpublished. Metcalf & Eddy, Inc., Boston, MA, 8 pages.

6. Geosciences Research Associates, Inc., 1984. Hydrologic Investigation of A.L. Taylor Site, Bullitt County, KY. Geosciences Research Associates, Inc., Bloomington, IN., 28 pages.

After completion of the 1982 Feasibility Study (FS) report, EPA requested that additional site hydrogeological data be collected (reports No. 1 and No. 2). The Ecology and Environment, Inc. (E&E)

and NUS Corporation (NUS) reports (No. 1 and No. 2) were then reviewed by a PRP consultant, Geosciences Research Associates, Inc. (GRA). Based on this review, GRA proposed to the EPA that a modified on-site containment alternative be adopted (report No. 3). Another PRP consultant, Tenech Environmental Engineers, Inc.(TEE). provided the EPA with a design report (No. 4) for the proposed modified alternative. EPA requested that M&E review the proposed modified alternative. M&E's report (No. 5) recommended further data gathering as a basis for final evaluation of the proposed alternative. EPA requested that the PRP furnish additional data (report No. 6) before a final determination could be made regarding the proposed site clean-up alternative.

1.1 E&E LETTER REPORT - SITE BORINGS (1982)

The remedial alternative recommended for the A.L. Taylor Site in the 1982 FS included the use of slurry walls and a leachate collection and treatment system. The EPA tasked E&E to determine the subsurface stratigraphy at the site in order to better evaluate the groundwater control measures.

E&E supervised the installation of two monitoring wells which were both located downgradient of the contaminated area. One well, ALDW-1, was located just to the south of the surface dumping area and north of the site. The other well was installed in the southwest portion of the site. The pressure permeability (double-packer) tests were also performed on suspected fracture zones in monitoring well ALDW-1 including the contact between the New Providence Shale and the New Albany Shale (36 to 41 feet,

ALDW-1). E&E determined that bedrock fractures were not extensive based on this testing. Groundwater was not detected during installation of monitoring well ALDW-2, therefore, no groundwater samples were recovered. E&E's letter report contained the following site observations:

- Lack of any vertical fracturing in the shales
- Tightness of clays
- Lack of groundwater in overburden clay

E&E made the following conclusions based on their field work and observations:

1. Migration offsite is very unlikely
2. The most likely avenue of groundwater transport is at the interface of the two shale units
3. Vertical migration of contaminants is very unlikely because of the approximate 85-foot thickness of the New Albany Shale
4. The Louisville limestone contains little groundwater (wells yielding less than five gallons per minute)
5. The limestone groundwater which is available is brackish in quality

1.2 NUS SAMPLING INVESTIGATION REPORT (1983)

In 1983, EPA requested that NUS gather additional site data regarding groundwater quality. More specifically, EPA tasked NUS to take groundwater samples from the limestone aquifer of ALDW-1 (Section 1.1) for subsequent analysis. The groundwater samples were taken in late November of 1982 and during the week

of March 24, 1983. Iron was detected in the November 1982 sampling at a concentration of 600 ug/l. This concentration exceeded the limits for both the National Drinking Water Standards and the Secondary Drinking Water Criteria. Zinc, a priority pollutant metal, was detected at a concentration of 530 ug/l, which is below the Secondary Drinking Water Criteria limit of 5,000 ug/l. The only organic compound detected was toluene at a concentration of 7 ug/l.

Acetone was detected at a concentration of 260 ug/l in the deep water-bearing zone prior to installation of a Barcad unit during March 1983 sampling. Four organic compounds were also detected in a sample collected in the shallow overburden zone during the March 1983 sampling. The four compounds and their concentrations are shown in Table 1-1.

TABLE 1-1
ORGANIC COMPOUNDS FOUND IN THE SHALLOW OVERBURDEN ZONE

Compound	Concentration (ug/l)
1,1,1-Trichloroethane	4 (estimated)
Toluene	4 (estimated)
Acetone	50
Methyl Isobutyl Ketone	36

NUS also analyzed the groundwater for potability. Chlorides were detected at concentrations of 1,300 mg/l at three different levels from the ALDW-1 groundwater monitoring well. NUS concluded that the groundwater is not potable because the

chloride concentration exceeds the 250 mg/l limit set forth in the Secondary Drinking Water Criteria.

1.3 MODIFIED CONTAINMENT ALTERNATIVE - GEOSCIENCE AND TENECH REPORTS (1983)

In 1983, GRA proposed a modified on-site containment alternative based on their review of the FS report and other site reports. Their recommended alternative was more comprehensive than the minimum action alternative proposed by the 1982 FS report, however, it did not contain the groundwater control measures which were included in the recommended on-site containment alternative. The specific measures that were proposed in the GRA design included:

- Impermeable cap and soil cover
- Drainage diversion trench
- Monitoring well system
- Site clearing, regrading and revegetation
- Security fence and signs
- Record plat

The FS recommended on-site containment alternative also included the following:

- Slurry wall
- Leachate/gas collection system
- Leachate treatment system

GRA concluded that a leachate collection system would only create an artificial zone of high permeability. The alternative

which GRA proposed is described in a report prepared by TEE and is entitled "Final Design Report for the A.L. Taylor Hazardous Waste Disposal Site". This report was prepared in September of 1983.

The recommended impermeable cap and soil cover consists of 18 inches of relatively impermeable compacted cover material (possibly the unweathered New Providence shale, if it meets the engineering specifications) covered by 6 inches of seeded top-soil. The New Providence shale (an argillaceous shale which appears to weather rapidly) was proposed because it typically has a low permeability coefficient (10^{-7} feet per minute). TEE also recommended using topsoil available at the site for cover material.

TEE has proposed the installation of seven groundwater monitoring wells for long-term monitoring. One well would be installed ungradient from the site to a depth of 100 feet while the other six monitoring wells would be located downgradient from the site and placed at a minimum of one foot into the unweathered shale layer. The downgradient monitoring wells would be screened only in the weathered shale zone. TEE assumed that the weathered shale layer was the most probable path for any groundwater movement, based on the available data. TEE planned to utilize any existing properly placed monitoring wells at the site as part of its proposed long-term groundwater monitoring program.

The details of the construction of the monitoring wells, cap and cover, diversion trenches, grading, vegetation, and fencing are included in a document prepared by TEE entitled "Contract Documents for Remedial Actions at the A.L. Taylor Hazardous Waste Disposal Site".

1.4 METCALF & EDDY LETTER REPORT (1983)

In 1983, EPA requested M&E review the proposed modified on-site containment alternative for the A. L. Taylor Site in Brooks, Kentucky. M&E submitted a letter report to the EPA outlining additional data gathering necessary for a complete evaluation of the proposed modified containment alternative. M&E recommended that the following additional data be collected:

- Location of any disposal cells and/or lagoons which may be located near the perimeter of the proposed closure
- Location of any off-site contaminant migration
- Location and monitoring of adjacent surface water (i.e., Wilson Creek and the farm ponds)
- Measurement of groundwater levels and water quality
- Determination of field permeabilities of the overburden and weathered shale

More specifically, the following actions were recommended:

1. Supplement surface anomalies with ground-truthing in order to determine the perimeter dimensions for the final cover

2. Install downgradient wells to assess off-site contaminant migration
3. Test Wilson Creek and farm ponds for contaminants
4. Install nine permanent monitoring wells in both the overburden and weathered shale. Two (2) wells would be located upgradient, three (3) on-site the facility, and two (2) downgradient double well clusters
5. Perform field permeability tests - falling head or slug test on monitoring wells installed in both the overburden and weathered shale.

The report also suggested that an alternative surface cap and cover be implemented because the proposed clay cap was not of sufficient thickness and did not include an impermeable membrane to prevent water from infiltrating the site. M&E recommended a surface cap and cover that would consist of the following elements based on RCRA guidelines:

- Gas collection and migration medium directly on the contaminated materials
- Two feet of clay (10^{-7} cm/s hydraulic conductivity) on the gas collection medium
- A 40 mil high-density polyethylene cover over the clay
- A one-foot drainage layer (1×10^{-3} cm/s hydraulic conductivity) over the polyethylene cover
- A synthetic fabric material (prevent soils from clogging the drainage layer) over the drainage layer
- Two feet of topsoil for planting over the synthetic fabric material

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The report also stated that the potential for floods from Wilson Creek had not been adequately addressed.

1.5 SITE HYDROLOGY - GEOSCIENCES' REPORT (1984)

In 1984, EPA requested that additional site data be gathered in order to fully evaluate the PRP proposed modified containment alternative. GRA, a PRP consultant, performed further site hydrologic investigations during 1984. A summary of their work is contained in a report entitled, "Hydrologic Investigation - A.L. Taylor Site, Bullitt County, Kentucky", dated May 9, 1984. GRA obtained this information by drilling at least six test borings, installing five monitoring wells, and performing nine laboratory permeability tests and four field permeability tests. Four groundwater and three soil samples were analyzed for volatile organics.

Two test borings, #4 and #5, were located off-site downgradient and east of the drainage ditch. A strong solvent smell was found at a shallow depth of Boring 5, however, little or no odor was detected at greater depth. A sample of soil from the shallow part of Boring 5 was sent to and analyzed by the Kentucky Department of Natural Resources and Environmental Protection Lab. Some of the contaminants found included toluene (16 mg/kg), ethyl benzene (146 mg/kg), orthoxylene (157 mg/kg), metaxylene (778 mg/kg), and paraxylene (127 mg). Another boring, Boring 4, had a strong solvent odor down to three feet depth and the odor gradually decreased to a depth of 10.5 feet. It was stated that the solvent odor in the deeper part of Boring 4 is

probably related to contaminated water, derived from shallower soil horizons. This boring was completed as an observation well and screened from 7 to 12 feet below ground surface. Groundwater samples from this depth showed toluene and ethyl benzene present in concentrations of 52.9 mg/l and 56.5 mg/l, respectively.

Laboratory permeability and field permeability testing were performed at the site. The laboratory permeability results varied from 1.7×10^{-8} cm/sec (at a sample depth of 8.1 feet to 8.6 feet in Well 1) to 7×10^{-7} cm/sec (at a sample depth of 2.8 feet to 3.3 feet in Well 5). Field permeability testing was successfully performed and the permeability was determined to be as high as 3×10^{-5} cm/sec.

Bail tests were successfully performed on Wells 4 and 5 and the results from these tests provided field permeabilities of roughly 3×10^{-6} cm/sec and 1×10^{-5} cm/sec, respectively.

The final conclusions reached in the GRA report include:

- Permeabilities of the materials encountered are very low
- Groundwater flow direction is om the site towards Wilson Creek and down Wilson Creek Valley
- Groundwater flow rates range from 0.8 cm/yr to 1.7 cm/yr
- Flow rates indicate very slow groundwater movement and insignificant contaminant release
- Contamination extent (depth) is related to surface contamination

- Subsurface contamination has occurred due to the migration of contaminants through the unsaturated zone to the water table, and not by lateral groundwater movement
- The proposed clay cap and vegetation cover will negate the release of contaminants by surface water flow and the potential of subsurface contamination

CHAPTER TWO

ENDANGERMENT ASSESSMENT

2.1 SITE DESCRIPTION AND HISTORY

The A.L. Taylor (Valley of the Drums) Site is a 23 acre site located in a valley in north-central Bullitt County, Kentucky. (See Figure 2-1, E&E 1982b). The valley slopes gently south-eastward toward Wilson Creek, a small brook running along the eastern edge of the site. The actual disposal area covers 13 acres of the 23-acre tract previously owned by Mr. Taylor.

The site was used by A.L. Taylor as a municipal refuse dump, a drum recycling center, and an industrial chemical dump from 1967 to 1977. As of 1979, EPA reported more than 17,000 drums on the site. Mr. Taylor was reported to have dug pits, emptied the contents of drums into them and recycled the drums (U.S. EPA 1982b).

Reports of spills of multicolored chemicals into Wilson Creek prompted the EPA to conduct emergency cleanup actions in the spring of 1979 under the authority of Section 311(K) of the Clean Water Act. In 1981, under the emergency provisions of the Superfund Act, EPA upgraded previous emergency actions. The emergency cleanup actions involved installation of a system of trenches to collect surface runoff and to intercept contaminated groundwater, a holding pond to collect runoff from the trenches, and a temporary activated carbon filtration system to treat the water in the holding pond prior to discharge to Wilson Creek (U.S. EPA 1982b). The temporary treatment system operated up

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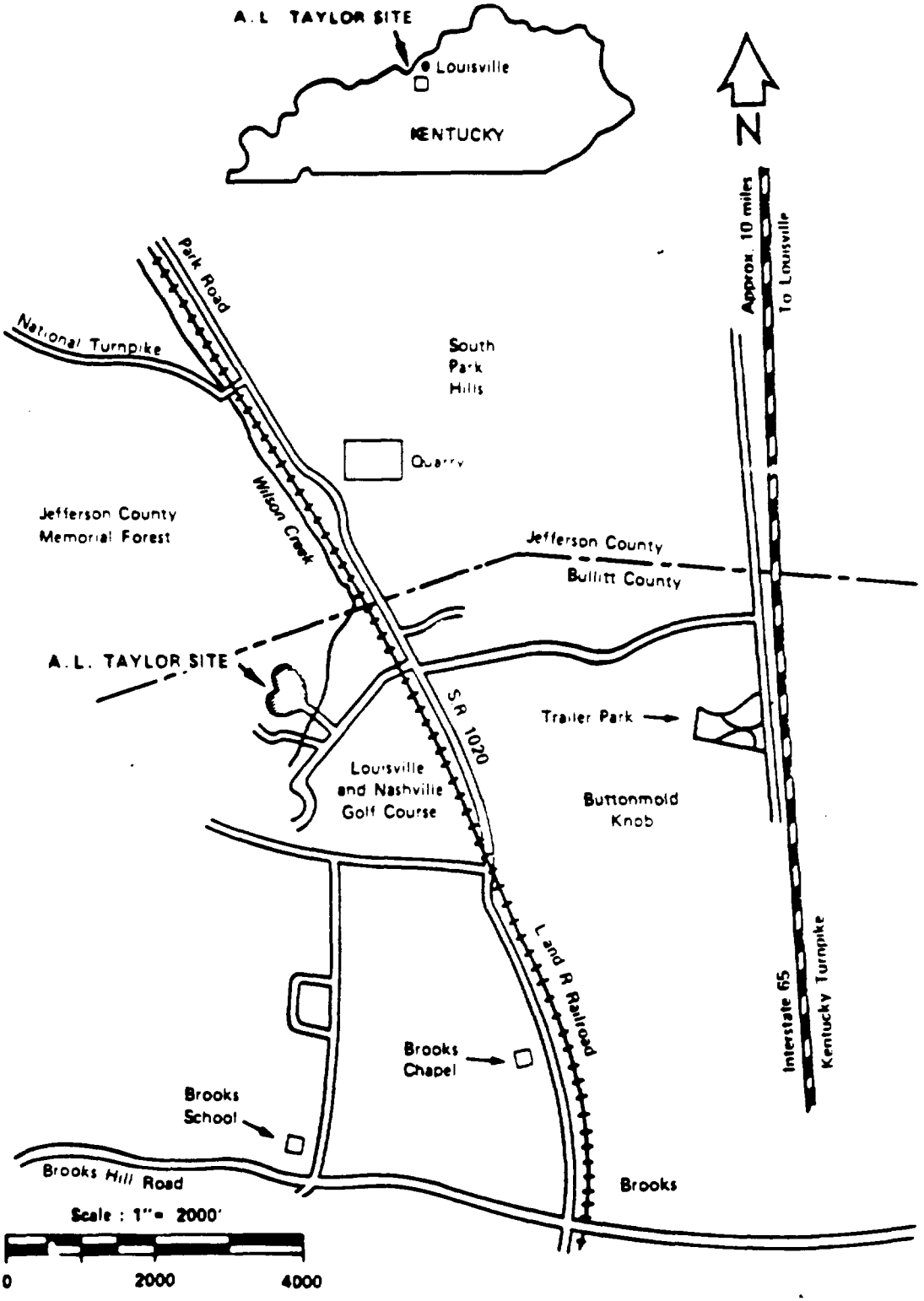

FIGURE 2-1. A.L. TAYLOR SITE LOCATION MAP

until 1981, but the trenches/holding pond are still in existence and both contain unknown quantities of standing water.

In addition to the water treatment system, the Kentucky Department of Natural Resources and Environmental Protection (KDNREP) approved segregation of wastes and removal of 16,000 empty, crushed drums to Smith's Landfill in Brooks, Kentucky about 3 to 5 miles away. Flammable solvents collected at this time were sent to a recovery facility. Twenty truckloads of contaminated silt, sludge and dredge material went to an approved disposal facility but a small amount of contaminated earth remaining from the removal operation was pushed into a pit and left on the site. The site received a final grading in November 1981.

Substantial volumes of buried wastes remain on the site. Geophysical studies by TECHNOS, Inc. in 1981 and by Ecology and Environment, Inc. (E&E) in 1982 indicated that as much as 12,500 cubic yards of materials, including 18,000 drums, may be located in various buried areas on the site (TECHNOS, 1981). Estimates of the total volume of contaminated soil resulting from buried wastes range from 12,500 to 31,000 cubic yards (E&E, 1982c).

A recent visit to the A.L. Taylor site by M&E, KDNREP, and EPA revealed that, despite grading efforts, the site is still subject to severe erosion. Substantial areas of vegetation were removed during previous remedial actions and vegetative cover continues to be sparse particularly on the steeper slopes from which soil was removed to cover burial pits.

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2.2 SITE CONTAMINATION

The A.L. Taylor site has been studied on several occasions between 1979 and 1984 to determine the extent of contamination at the site. The basic findings of these studies are presented below. A major limitation of this body of data is that the most extensive sampling was generally conducted in 1979 before initial cleanup of the site, making it difficult to assess the likely impact of current conditions. For instance, no recent analyses of Wilson Creek have been conducted. In addition, later studies were not always effectively used to confirm and extend the information collected in 1979; analyses were not always carried out for the same compounds or at similar depths or locations. Direct comparison of studies is therefore difficult. Despite these limitations, this section attempts to assess the current extent of contamination by describing historical patterns of contamination and comparing them as much as possible with more recent evidence.

Summary of Site Investigations. Prior to cleaning and grading the site, EPA conducted sampling studies in February, March and April of 1979 to measure levels of contaminants in the soil, groundwater, and surface runoff (EPA, 1979a). Sediment and liquid samples were taken from ten test pit locations, seven surface runoff locations, and from the site's runoff holding pond (See Figure 2-2; E&E, 1982b). Soil borings to depths up to 18 feet were taken at 12 locations to determine the vertical extent of contamination. EPA also took water and sediment samples along

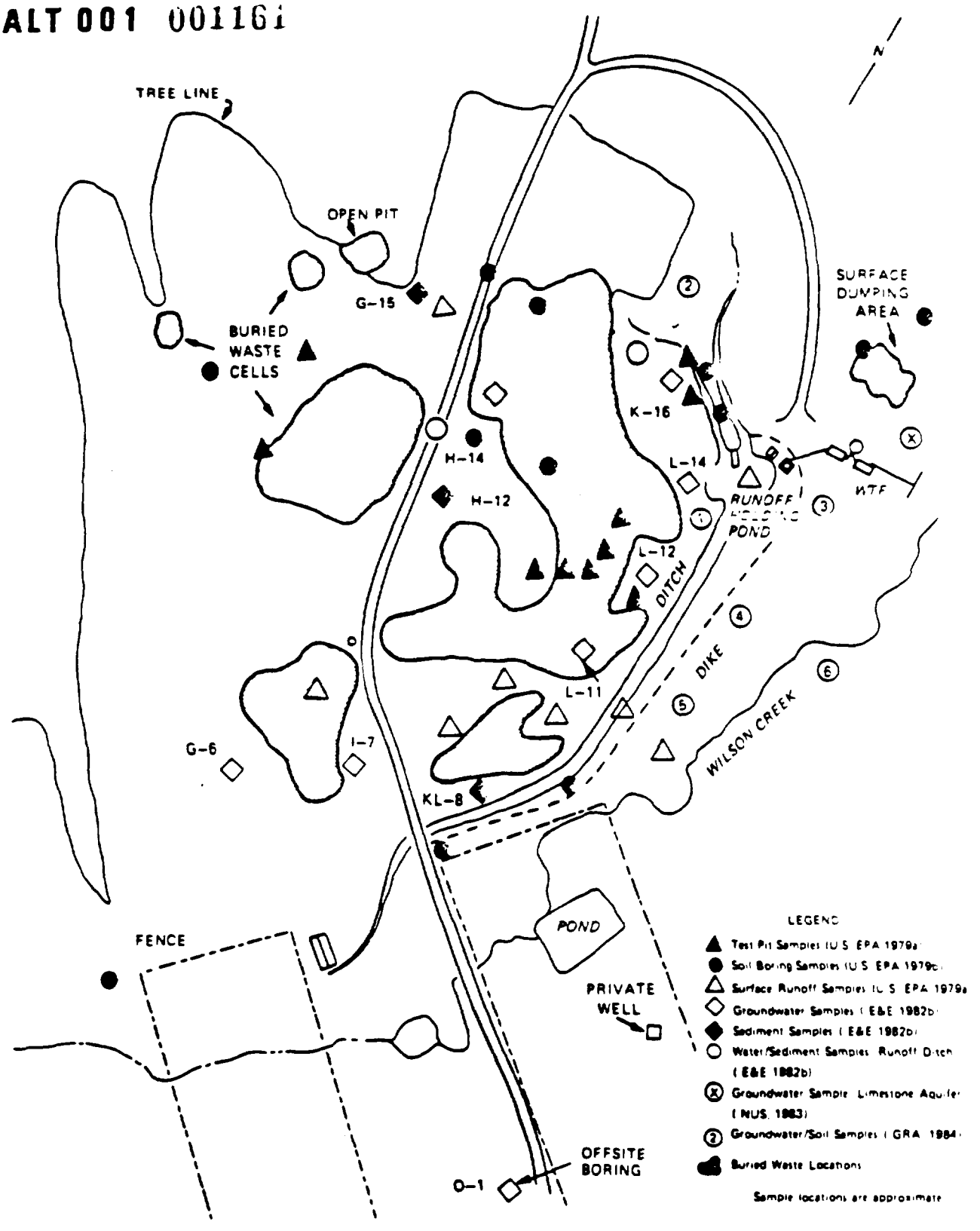

FIGURE 2-2. SAMPLING LOCATIONS AND SUSPECTED WASTE DISPOSAL AREAS (SHADED AREAS)

Wilson Creek (WC-1 to WC-4) and from rivers downstream of Wilson Creek (See Figure 2-3; U.S. EPA, 1979a).

The State of Kentucky conducted a sampling study of benthic and other organisms from Wilson Creek, Southern Ditch, and Pond Creek (See Figure 2-3 U.S. EPA, 1979a). The purpose of their study was to characterize the organisms potentially affected by the A.L. Taylor Site and to measure levels of contaminants that may have accumulated in those organisms. Samples were analyzed by EPA Region IV's Laboratory in Athens, Georgia (U.S. EPA, 1979c).

As part of a remedial investigation, E&E conducted further sampling of soil, groundwater and runoff in 1982 (E&E, 1982c). Groundwater samples were collected from seven on-site soil borings, one offsite and one from a private drinking water well on the opposite side of Wilson Creek. Several soil samples were taken for comparison with the 1979 EPA soil analyses. One 200-foot well was established 77 feet into the deep confined limestone aquifer (Louisville) beneath the site and was sampled in 1982 and in 1983. More recently, Geosciences Resources Associates, Inc. (GRA) installed and sampled from 5 monitoring wells and one boring in order to evaluate the extent of horizontal migration of contaminants toward Wilson Creek (GRA, 1984). The KDNREP analyzed soil from one of the borings installed by GRA for organic chemical contamination. Unlike previous investigators, GRA sampled for only five target organic chemicals; chloroethane, dichloroethene, dichloroethane, toluene,

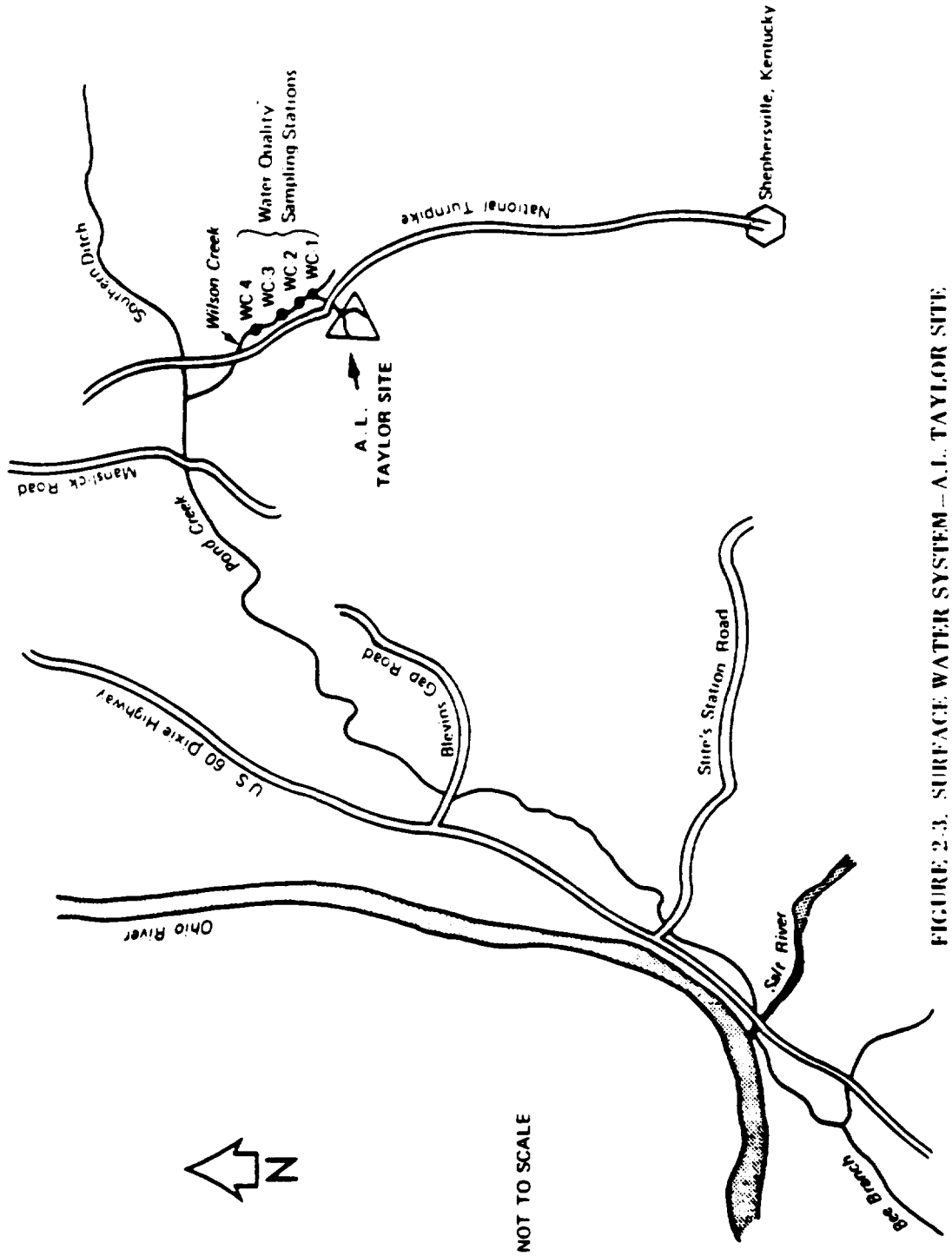

FIGURE 2-3. SURFACE WATER SYSTEM—A.L. TAYLOR SITE

and ethyl benzene. Chloroethane and dichloroethane were not among those compounds most commonly found on the site.

No monitoring for ambient airborne contaminants from the A.L. Taylor site has been conducted.

Extent Of Contamination. Over the course of investigations at the Taylor site, approximately 140 compounds have been identified. The chemicals found most often and in highest concentration include xylene, phthalates, toluene, alkyl benzenes, methyl ethyl ketone, methylene chloride, acetone, anthracene, vinyl chloride, trans-1,2 dichloroethylene, fluoranthene, and several long chain aliphatic acids. Polychlorinated biphenyls (PCBs) were found in low concentrations in surface soils at two locations and in sediments sampled in Wilson Creek. Several metals including barium, lead, zinc, copper, strontium, magnesium and chromium have been found in soils, runoff and groundwater in concentrations exceeding natural background levels.

The highest concentrations of chemicals detected were found in liquid sampled from test pits dug in areas indicated by geophysical studies to contain buried wastes (U.S. EPA, 1979a). The liquid, which is likely to be a combination of groundwater and liquid waste, contained several million micrograms per liter of xylene and bis (2-ethylhexyl) phthalate among other compounds. The average concentration of the major compounds detected are presented in the first column of Table 2-1. High concentrations of barium, lead, strontium, nickel and zinc were also reported (U.S. EPA, 1979a).

TABLE 2-1. ORGANIC CHEMICAL CONCENTRATIONS IN GROUNDWATER. A. L. TAYLOR SITE

	Test Pit Liquid[1] 1979		Test Soil Borings[2] 1982	
	Average Condition		(Std. Deviation) ug/l	
Acenapthene	36,000	(80,498)	--	
Anthracene/Phenanthrene	34,000	(76,026)	--	
Bis (2-ethylhexyl) Phthalate	580,641	(1,296,562)	--	
Ethyl Benzene	7,704	(10,106)	1,150	(2,371)
Methyl Ethyl Ketone	7,940	(10,926)	--	
Methyl Isobutyl Ketone	9,976	(12,995)	--	
Napthalene	240,020	(536,645)	38	(28)
Toluene	11,980	(10,643)	1,642	(1,879)
Trans 1,2-Dichloroethylene	33,680	(70,648)	302	(598)
Vinyl Chloride	989	(1,264)	30	(60)
Xylene	2,212,360	(4,912,446)	NQ[3]	

1. U.S. EPA, 1979a. Liquid found in test pits dug by backhoe in principal area suspected of containing buried wastes. A-4, A-5, A-6, A-7, A-10. When no value was reported for a given site, zero concentration was assumed.
2. U.S. EPA, 1982c. Test wells drilled downgradient of same principal burial area. Average of K-16, L-14, L-12,L-11. When not detected in a given test well, zero ug/l was assumed.
3. NQ - Detected but not quantified.

ALT 001 0011C

Analyses of groundwater from soil borings completed subsequently have indicated contamination by many of the same chemicals (E&E, 1982c). Table 2-1 compares concentrations of chemicals found in the test pits with concentrations in soil borings completed by E&E in locations believed to be downgradient of the same test pits (see Figure 2-2). Since E&E did not sample for all the same compounds as EPA in 1979, a direct comparison is not possible in all instances, but the results showed contamination by ethyl benzene, napthalene, toluene, trans-1,2-dichloroethylene, and vinyl chloride. GRA installed a monitoring well in 1984 near the E&E soil borings. None of the five target compounds were detected.

Only one of the four wells sampled by GRA was contaminated by any of the five target compounds. Well 4, located between Wilson Creek and the drainage trenches contained toluene (52.9 mg/l) and ethyl benzene (56.5 mg /l) (See Figure 2-2, E&E, 1982b). However, GRA's Well 5, which was sampled by KDNREP, was found to contain toluene (16 mg/kg), ethyl benzene (146 mg/kg), and xylene (all isomers - 1062 mg/kg) in sediments. GRA did not sample for xylene. No organic chemicals were found in the offsite boring or in the offsite private well (E&E, 1982b).

Sampling results from the deep well have yielded conflicting results about the possible contamination of the limestone aquifer. Samples collected with teflon bailers showed 7 ug/l of toluene in 1982 and 260 ug/l of acetone in 1983 (NUS, 1983). Sampling after installation of a Barcad sampling device

designed to isolate the two water bearing formations at the site showed no contamination by organic chemicals. It is not possible to determine the source of contamination of the deep well given current information.

Several metals were found in elevated concentrations in groundwater. Cobalt, chromium, copper, nickel, lead, cadmium and zinc were found in elevated concentrations in some wells but only lead was statistically significantly higher in on-site wells than in the offsite boring (see Table 2-2). Concentrations for chromium, copper, zinc and cadmium were still below National Drinking Water Standards.

Soil boring studies conducted by EPA in 1979 to evaluate the vertical extent of contamination showed widespread contamination of surface soils by organic chemicals and metals. Concentrations of organic chemicals were generally highest in the top two feet with only trace amounts detected to depths of six feet. Contamination to depths of 18 feet was detected in only a few samples. Table 2-3 presents ranges of organic chemicals found in the top two feet of soil and in sediments from runoff ditches. Table 2-4 compares concentrations of metals found in the top two feet of contaminated areas with those found in control locations. Only levels of nickel, calcium and sodium were statistically significantly elevated for the site as a whole.

Both organic chemicals and metals have been found in the sediment and runoff water from temporary drainage ditches. EPA in 1979 found elevated concentrations of xylene, hexadecanoic

TABLE 2-2. METALS CONCENTRATION IN GROUNDWATER (ug/l)[1]. A. L. TAYLOR SITE

	Offsite Boring[2]	Private Well[3]	Onsite Boring[4]		National Interim Drinking Water Standards
Aluminum	1,100	4,600	1,079	(1,288)*	NA[6]
Cadmium	ND[5]	ND	6	(7)	10
Chromium	30	ND	35	(23)	50
Cobalt	55	ND	69	(60)	NA
Copper	ND	12	19	(33)	1,000
Iron	3,300	9,500	7,200	(6,154)	300
Lead	8	ND	82	(61)	50
Manganese	3,900	145	1,751	(2,296)	50
Nickel	49	ND	107	(109)	NA
Strontium	ND	263	ND		NA
Titanium	ND	33	ND		NA
Zinc	40	71	71	(35)	5,000

1. Ecology and Environment, 1982c.
2. Offsite boring (control)
3. Private well, 60 ft. deep, southeast of the site
4. Soil boring completed in locations believed to be downgradient of disposal pits or trenches.
5. Not Detected
6. Not Available or Established

* Average (Std. Deviation)

ALT 001 001163

TABLE 2-3. ORGANIC CHEMICALS IN SURFACE SOILS (mg/kg). A. L. TAYLOR SITE

Compound	Runoff ditch sediment[1] 1979	Surface Soil[2] 1979	Runoff ditch sediment[3] 1982
Acetone	6[4]	-	0.150[6]
Anthracene/Phenanthrene	1-10	T-48	-
Bis (2-ethylhexyl) Phthalate	120	T-2,800	ND
Butyl Benzyl Phthalate	-	-	-
Di-N Butyl Phthalate	1-10	T-55	-
Ethyl Benzene	0.6[4]	-	0.140
Fluoranthene	-	T-43	-
Hexadecanoic Acid	T-570	T-370	4.000[6]
Napthalene	11[4]	T-360	0.640
Pyrene	-	T-55	-
Trans-1,2-Dichloroethylene	(Trace)	-	<0.010
Xylene	330[4]	T-1,000	2.700[6]
Arochlor 1242	-	T-1.2	ND
1254	-	T-3.1	ND
1260	-	T-4.0	ND

1. U.S. EPA, 1979c. Report did not state whether results were in wet or dry weight. Samples taken from sediment of temporary runoff ditches.
2. U.S. EPA, 1979b. Mg/kg dry weight. Samples taken within top 2 feet of surface soils.
3. E&E, 1982c. Results from one sediment sample from runoff ditch.
4. Only one value reported.
5. Not reported
6. Tentative identification. Concentrations estimated.

ALT 001 001163

TABLE 2-4. METALS CONCENTRATION IN SURFACE SOILS(mg/kg dry weight) A. L. TAYLOR SIT

Metal	Control Location[1] 1979	Contaminated areas[1] 1979		Runoff ditch[2] 1982
Silver	1.254	1.4	(0.5)	3.5
Barium	56.0	339.9	(728.9)	80.0
Cobalt	-	-		7.0
Cadmium	1.25	4.0	(6.4)	NR
Chromium	17.00	512.7	(1,924.3)	10.0
Copper	10.5	793.3	(2,996.6)	60.0
Nickel	24.00	80.9	(77.4)*	ND[4]
Lead	<13.0	2,628.1	(10,037.5)	270.0
Tin	<6.3	17.2	(28.1)	-
Strontium	5.5	42.6	(48.8)	-
Titanium	17.00	67.3	(103.7)	-
Thallium	<13	19.1	(25.3)	-
Zinc	78.0	442.7	(987.6)	70.0
Calcium	161.0	6,311.6	(10,229.5)*	-
Magnesium	3,292.0	5,588.3	(5,706.2)	-
Aluminum	15,962.5	15,113.1	(5,755.2)	1,000
Iron	29,093.5	46,342.6	(47,166.9)	3,450
Manganese	751.5	652.6	(601.2)	140
Sodium	124.5	205.7	(139.8)*	-

1. U.S. EPA, 1979
2. Ecology and Environment, 1982c. One sediment sample.
3. Not detected
* Significantly higher than control location $p<.05$

ALT 001 001170

acid, and bis (2-ethylhexyl) phthalate in ditch sediments (Table 2-3, column 1). Sampling in 1982 indicated that concentrations of organic chemicals in runoff sediments are still elevated although they are substantially lower than those found in 1979. Napthalene (640 ug/kg), butyl benzyl phthalate (940 ug/kg), ethyl benzene (140 ug/kg) and toluene (230 ug/kg) were present in highest concentrations (E&E 1982c). The runoff water collected by E&E in 1982 contained toluene (320 ug/l), 1,2 trans-dichloroethylene (12 ug/l), ethyl benzene (150 ug/l) and methylene chloride (30 ug/l).

Metal concentrations in sediments and runoff were also elevated. Table 2-5 compares metals concentrations in the runoff sample taken in 1982 with concentrations found in groundwater control samples. The data show that only concentrations of lead and iron were higher than both control values and National Primary and Secondary Drinking Water Standards.

Few data were available on contamination of Wilson Creek water and sediments. Wilson Creek was sampled only in 1979 by EPA and showed contamination by several of the organic chemicals found in high concentrations on the site. Results of the water samples are presented in Table 2-6. The sediments contained only trace amounts of these chemicals. Polychlorinated biphenyls (Arochlor 1254, 1260) were detected at relatively low concentrations ranging from 0.01 - 3.0 ug/kg in all Wilson Creek sediment samples (EPA 1979a).

TABLE 2-5. METALS CONCENTRATION IN SURFACE RUNOFF (ug/l)[1]

	Control[2] (groundwater)		Runoff[3]	Standards[4]
Cobalt	28	(39)	60	NA[6]
Chromium	15	(21)	32	50
Copper	6	(8)	100	1,000
Nickel	25	(35)	59	NA
Lead	4	(6)	140	50
Zinc	56	(22)	170	5,000
Aluminum	2,850	(2,475)	2,500	NA
Manganese	2,023	(2,655)	5,000	50
Strontium	132	(186)	ND	NA
Iron	6,400	(4,384)	16,000	500
Titanium	17	(23)	ND	NA
Cadmium	ND	(5)	5	10

1. Ecology and Environment, 1982c
2. Samples from 0-1 (control), PW-RO (Private Well)
3. One water sample from runoff ditch
4. National Drinking Water Standards
5. Not Detected
6. Not Available. Standards not yet established for these metals.

TABLE 2-6. ORGANIC CHEMICAL CONCENTRATIONS IN WILSON CREEK(1)A.L. TAYLOR SITE.
FEBRUARY 1979
(ug/l)

Sample Location(2)	WC-001	WC-002	WC-003	WC-004
Compound: (3)				
Acetone	8,400(4)	9,300	ND	ND
Methyl Ethyl Ketone	5,000(4)	6,300	ND	ND
Methyl Isobutyl Ketone	2,000	13,000	ND	ND
Methylene chloride	58	52	ND	ND
Heptanone	62	103	48	35
Trans-1,2-Dichloroethylene	43	114	ND	ND
Xylene	6.3	6.8	22	13
Diethyl phthalate	18	ND	11	4.0
Bis (2-ethylhexyl) phthalate	Trace	ND	ND	ND
Heptanol	ND(5)	48	15	11

1. U.S. EPA. 1979a
2. WC-001 - Wilson Creek confluence with drainage ditch from Taylor site
   WC-002 - 170 yards downstream of WC-001
   WC-003 - 180 yards downstream of WC-002
   WC-004 - 190 yards downstream of WC-003
3. Only chemicals that were specifically identified (as opposed to chemical class) and present in the highest quantities are reported.
4. Approximate. These data were taken from a handwritten data sheet which was difficult to read from a few entries.
5. Not detected. No entries were recorded for these compounds although they were apparently analyzed for.

Metal concentrations were also found to be elevated in Wilson Creek water and sediments during the 1979 sampling program. However, although water concentrations of barium, lead, copper, zinc, and nickel were several times higher in the section of creek closest to the site compared with the upstream control location, they were no higher than the concentrations from control locations further downstream. In contrast to these results, metal concentrations in sediments were highly variable along the lengths of the creek sampled. Concentrations of chromium, copper, nickel, lead, zinc, magnesium and manganese were generally highest compared to control values at the sampling location furthest from the site. No other metals were detected that were above background levels for the area.

Limited sampling conducted in rivers downstream of Wilson Creek did not indicate substantial contamination by the Taylor Site. Concentration of organic compounds found up and down stream of the confluence of Wilson Creek with Southern Ditch were reported to be "low" in both water and sediment samples (5 mg/kg) (U.S. EPA, 1979a). Pond Creek was also reported to have low concentrations of organic chemicals in water and sediment samples. PCB's were detected in two samples (0.018 and 0.0047 mg/kg).

2.3 ENVIRONMENTAL FATE AND TRANSPORT

The objective of this section is to define and characterize the transport pathways for contaminants at the A.L. Taylor Site. The determination of transport pathways will be

based on an evaluation of the site hydrogeologic characteristics and the chemical/physical properties of chemicals found.

Hydrogeological Evaluation

Topography. The A.L. Taylor site is located near the upper end of a valley that slopes generally toward Wilson Creek. The western and northern sides of the site are characterized by valley walls and slopes of 20 to 30 percent. These steep slopes, which are the result of excavations into the sides of the valley, are currently unvegetated and subject to erosion.

The rest of the site is characterized by more gentle slopes. The northeastern edge of the site is bordered by a hill with a slope of approximately 12 percent, while the southern portion of the site has moderate relief with a consistent slope of approximately 7 percent. Most of the surface area at the site has been graded or in some way physically altered so that the land gradually slopes eastward toward Wilson Creek. The southwestern third of the site drains toward the southeast along established drainage patterns. Runoff from this area spreads out into sheet flow and eventually drains to Wilson Creek.

Soils. The overburden at the site typically consists of a surficial layer of silty clay which varies from 1 to 14 feet thick. Little topsoil remains on much of the site, since surface soils in the area used for waste disposal were significantly altered by excavation and grading during operations and emergency cleanup. A zone of weathered shale, typically 1 to 11 feet thick, occurs beneath the silty clay.

Geology. The site is underlain by the New Providence Shale, the New Albany Shale, the Louisville Limestone and the Waldron Shale. Site-specific data regarding three of these formations were obtained during the drilling of two bedrock wells at the site.

The New Providence shale, the uppermost bedrock unit, varied in thickness from 13 to 48 feet in the two wells. Continuous cores were obtained throughout this shale in both holes. It was reportedly weathered throughout its entire thickness, with the degree of weathering decreasing with depth. No evidence of vertical fracturing or jointing was seen in the cores. Horizontal partings were noted, mainly just above the contact with the New Albany shale.

The New Albany shale underlies the New Providence shale. It was cored throughout its thickness of 85 feet in only one of the wells. The cores indicated that the New Albany shale beneath the site is massive and unweathered, with no evidence of vertical fracturing and few zones of horizontal partings or fractures.

The Louisville limestone underlies the New Albany shale. It was penetrated by only one of the wells. Only the uppermost eight feet of the limestone were cored. The cored sections were described as vuggy, indicating that cavities were present which may have been lined or filled in with minerals. Regional geology suggests that the Louisville limestone is not likely to be

cavernous.[1] Water in the limestone will therefore generally move along in interconnected fractures and solution channels (E&E, 1982).

Hydrogeology. Permeability values for some of the subsurface materials at the site were determined during the investigations of both E&E and GRA. Permeability tests were conducted both in the laboratory (standard methods) and in the field (bailer tests, pumping tests, and packer tests).

The silty clay and the weathered shale are considered as a single layer in the hydrogeologic analysis. The layers are texturally similar and separated by a gradational boundary.

The silty clay and weathered shale layers were tested by several different methods at several different locations. Eleven laboratory permeability tests, which measure vertical permeability, were conducted by E&E and GRA. The laboratory tests produced permeability values in the range of 1.7×10^{-8} to 7.0×10^{-7} cm/sec. Two bailer tests and one pumping test were conducted in the field by GRA. These tests, which are more indicative of horizontal permeability, indicated values between 1.8×10^{-6} and 3.3×10^{-5} cm/sec.

The permeabilities of the shales at the A.L. Taylor site were also tested by laboratory and field methods. One sample of unweathered New Providence shale was collected by GRA and tested in the laboratory. The permeability was 6.3×10^{-8} cm/sec.

(1) Personal Communication. Hal Hackett, Geologist, Kentucky Department of Natural Resources & Environmental Protection. July 11, 1984.

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Pressure permeability tests, or packer tests, were conducted on three intervals in one of the bedrock monitoring wells drilled during the E&E investigation. The tests, two of which were done in known or suspected fracture zones at the contact between the shales and in the New Albany shale, indicated low permeabilities. Actual permeability values were calculated by TEE, using the data from E&E. The resulting values were 4.0×10^{-4} to 9.6×10^{-4} ft/min, or 2.0×10^{-4} to 4.9×10^{-4} cm/sec, for the fracture zone near the contact; impermeable in an unfractured zone in the New Albany shale; and 2.75×10^{-5} ft /min, or 1.4×10^{-5} cm/sec, in a fracture zone in the New Albany shale. Additional evidence of the low permeabilities in the New Providence shale was found in the second E&E bedrock well. That well, which was drilled to a depth just below the contact between the two shale formations, reportedly yielded so little flow that it could not be sampled three days after being pumped out. A privately-owned, offsite well which is believed to be completed in the shales also showed an extremely low yield.

The yield from the Louisville Limestone beneath the site appears to be relatively low. The one bedrock well established 77 feet into the limestone yielded only 4 gallons per minute (gpm) after 15 minutes of pumping.

Groundwater Flow. Although there is substantial disagreement among the various investigators at the Taylor site, groundwater appears to be present in three major strata: the shallow, unconsolidated overburden, the weathered shale, and the

deep confined limestone. The silty clay layer and the weathered shale have been assumed to consist of one single layer for the purpose of this analysis.

The silty clay/weathered shale layer varies in thickness from approximately 3 to 25 feet. Water levels measured in hand-augered wells in this zone ranged from 1.2 to 9.6 feet below land surface (E&E, 1981; E&E, 1982c; GRA, 1984). Based on the topography and on water levels in wells and borings, groundwater in this zone is likely to flow from the hills southeasterly toward the valley of Wilson Creek.

Another possible direction of groundwater flow from the site was identified during the previous review. It was discovered that the southwestern corner of the A.L. Taylor Site was near a drainage divide between the Wilson Creek valley which drains to the north and an unnamed creek which drains to the south and east.

However, no water-level contour map has been prepared for the site, nor has it been determined whether Wilson Creek is a discharge point for groundwater in the overburden.

The volume and rate of groundwater flow through the silty clay/weathered shale are estimated to be extremely low, based on the low permeabilities and the small saturated thickness. Using the permeability values and estimated gradients from the previous investigations, it is possible to estimate a volume and rate of flow. The calculated permeability values from the bailer tests and pumping tests are the best indicators of the horizontal

permeability of this zone. The average permeability value from those three tests was 1.4 x 10^{-5} cm/sec. Assuming a flow path 500 feet wide, a saturated thickness of 7 feet, and a gradient of .05, the estimated volume of flow is about 19,000 gallons/year (see Appendix A). The corresponding flow velocity, assuming a porosity of 0.3, is 2.4 ft/yr.

The New Providence and New Albany shales were also shown by the remedial investigations to be poorly permeable. Small quantities of groundwater may be transmitted at slow rates through the shales, in directions governed by interconnected fractures (if any) and hydraulic gradients. However, the low permeability and apparent lack of vertical fracturing indicate that downward movement of water is relatively unlikely.

The low yield of the well installed in the Louisville limestone indicates that the limestone is only moderately permeable. It was not studied in detail, since it is believed to be isolated from the on-site contaminated soils by about 100 feet of shale.

Surface Water. The A.L. Taylor Site is located in the Salt River drainage basin which ultimately flows into the Ohio River. The site drains initially into Wilson Creek, a small tributary originating from a spring south of the site. Wilson Creek flows northward, first joining Southern Ditch, then Pond Creek, then the Salt River and finally the Ohio River.

The normal flow rate of Wilson Creek is about 0.1 cfs (E&E, 1982b). However, the flow rate is subject to substantial

fluctuation from seasonal storm and snowmelt water. The average precipitation for the area is about 43 inches per year (NOAA, 1979) and high intensity rainfalls of more than 4 inches per hour occur annually. Thus, the flow cycle of streams, such as Wilson Creek, is one of rapid, heavy discharge after a moderate rainfall leading to stream-cleansing actions such as dilution, flushing, and streambed scouring.

The volume of water contributed to Wilson Creek by surface runoff is estimated to be far greater than that contributed by groundwater. The volume of surface runoff calculated for the A.L. Taylor Site and the ground extending from the edge of the site to the top of the hill range from 2.7 to 5.4 million gallons per year. The lower value represents 20 percent of the annual rainfall assuming the land surface has heavy vegetation with more evapotranspiration and infiltration into the ground. The higher value represents 40 percent of the annual rainfall assuming that there is sparse vegetation with less evapotranspiration and less infiltration into the ground. The average value for runoff calculations was taken from TEE, 1983. All calculations are shown in Appendix A.

Hydrological Evaluation Conclusions. M&E makes the following conclusions based on a conservative value of permeability:

1. Approximately 19,000 gallons per year of groundwater flows offsite in the direction of Wilson Creek through the overburden/weathered shale formations.

2. Groundwater moves offsite in the direction of Wilson Creek at a rate of 2.4 feet per year.
3. It will take 20 years for groundwater to move a horizontal distance of 50 feet in the overburden/ weathered shale formation.
4. The volume of surface runoff towards Wilson Creek from the site ranges from 2.7 to 5.4 million gallons per year which is 100 to 200 times greater than offsite groundwater flow in the overburden/weathered shale formation.
5. There is insufficient available information on the Louisville limestone aquifer to determine offsite groundwater flow rates.

Physical/Chemical Properties.

The types of compounds detected at the Taylor Site include two principal groups: metals such as lead, zinc, copper and chromium; and organic compounds used in coatings manufacturing such as solvents, degreasers, plasticizers and resins. Other than these two major classes of compounds cyanide was found in the one 1982 leachate sample and PCBs were found in two locations.

The organic compounds detected in surface soils and test pits at the site include two general groups: volatile compounds including methylene chloride, tetrachloroethane, methyl ethyl ketone, acetone, ethyl benzene, xylene, trans-1,2-dichlorothylene and semi-volatiles such as phthalate esters (di-n-butylphthalate,

bis(2-ethylhexyl) phthalate) and polynuclear aromatics (anthracene, phenanthrene, pyrene, fluoranthene, naphthalene). In general, these compounds will volatilize to varying degrees from exposed soils, surface waters, or leachate, to the air where they may be dispersed and transported. The more volatile compounds may move slowly through the upper soil layers by diffusion and convection and volatilize from the pore water to the atmosphere. In general, the volatile compounds are highly subject to photo-oxidation in the atmosphere which is the major fate process for these chemicals (U.S. EPA, 1979d). PCBs, which were also detected at the site, have extremely low aqueous solubilities and low vapor pressure, and thus will not tend to volatilize from the site.

The semi- and non-volatile compound groups will tend to adhere to the clay particles, which are a significant component of the soils at the site, and not volatilize to any significant extent, with the exception of bis(2-ethylhexyl) phthalate and butyl benzyl phthalate. These compounds, due to their low aqueous solubilities, will have a greater tendency to volatilize than other phthalates, but still are not considered highly volatile compounds. The phthalates as a group are also subject to biodegradation and metabolic transformation by biota, but the degree to which these are major fate processes is unclear (U.S. EPA 1979d).

Although evaporation of the more volatile organics can be a major fate process for these compounds from surface water and

most soils, these compounds can also be strongly adsorbed to clay.

Generally, the permeabilities of packed clay columns are lower to organic solvents than to water. This can be attributed to the tendency of an organic molecule to be adsorbed on clay, and to various other factors including microbial-decomposition and subsequent liberation of gases which may clog clay pores. Research indicates, however, that some solvents cause clay to shrink appreciably, thereby endangering the ability of the natural clays to prevent pollution migration. Even though such a solvent may move slowly through a wet clay by diffusion and convection, there is in principle a danger that it will eventually cause shrinking and cracking which would allow fluid transmission in bulk. This phenomenon is very specific to the solvent (solvents) in the lecheate and the type of clay exposed to the solvent. No information indicates that this has occurred or would ever occur at the A.L. Taylor Site (E&E, 1982b). In general, it is expected that the clay soils present at the site would partially attenuate the movement of the organic compounds both within the soil, and from soil to the air, but the extent of such attenuation is not quantifiable given the available information.

The other group of compounds detected at the site are metals, including nickel, chromium, copper, lead, zinc, titanium, iron, and barium. In general, these metals will remain strongly adsorbed to soil particles by anion and cation exchange, and will

not be readily released to surface or groundwater. Under conditions of extreme high or low pH, certain metals become soluble and therefore potentially available for transport in waters. The degree to which these conditions may occur at the Taylor Site is not quantifiable, but is not expected to be significant. The metals at the site will typically be adsorbed to soil particles, and may be transported from the site via sediment carried in runoff. In general, metals are not subject to volatilization, photodegradation, or biotransformation processes which would alter the concentrations found at the site.

Environmental Pathways.

Based on the description of the site and the nature and extent of contamination found at the site, four possible pathways for transport of contaminants have been identified:

- soil surface to air
- soil surface to surface water via runoff
- groundwater to surface water via groundwater discharge
- on-site groundwater to offsite soil and groundwater

Three of the four possible environmental pathways initially identified are determined to be insignificant at the A.L. Taylor site. The soil surface to air pathway is not important due to retention of most of the organic compounds found by the clay/silt soils at the site, and rapid photodegradation of any volatile organics that do evaporate to the air. Transport of contaminants by groundwater to either surface water, or offsite soil and groundwater, is minimal due to the relatively small

amount of groundwater discharged annually from the A.L. Taylor site, and significant attenuation of metals and organics by the silt/clay soils through which the shallow groundwater moves.

The principal pathway for movement of contaminants from the A.L. Taylor site is from the soil surface to surface water by runoff. The hydrological evaluation determined that significant quantities (2.7 to 5.4 million gallons per year) of surface runoff are discharged from the A.L. Taylor site. Contaminants found at this site may be transported in surface runoff as dissolved constituents, or more likely adsorbed to soil particles. The principal discharge point for runoff are the drainage ditches constructed in 1978 and Wilson Creek. Normal rainfall conditions may continually erode surface soils and expose contaminated soils or barrels which may be buried at the site. Under heavy rainfall conditions, contaminated soil and leachate may be discharged from the site primarily to Wilson Creek, but the loadings of these contaminants are not quantifiable based on available data, nor may loadings be projected based on future erosion conditions.

2.4 EXPOSURE EVALUATION

Public Health

Several routes of human exposure to toxic chemicals were evaluated for the A.L. Taylor Site: drinking water and other household uses of groundwater and surface supplies; airborne exposures to organic vapors or to contaminated particulate matter from the site; direct contact with contaminated soils or sludges

and finally, exposure via ingestion of fish or absorption during swimming in surface waters contaminated by the A.L. Taylor Site. Each route of exposure was evaluated for both the likelihood and, where possible, the magnitude of the exposure.

Population at Risk*. Bullitt County is relatively sparsely populated. Over 90 percent of the land along the north-central border of Bullitt County is classified agricultural or otherwise vacant. Single-family residential, accounts for roughly 10 percent of the total acreage in north-central Bullitt County (Schoenbaechler, 1982 in U.S. EPA 1982).

However, several families live within a mile of the Taylor Site. Five single-family homes are located along Letts Road, which runs along the southern border of the site. The community of Brooks is about 1.5 miles southeast of the site. Single-family homes located on roads branching from Brooks Hill Road also fall within a 1-mile radius of the site. A trailer park, concentrated residential area, is located about 3,500 feet east of the site adjacent to Interstate 65. A quarry representing the only small industry in the projected area is northeast of the site along the National Turnpike. A privately owned Golf Course lies south of the site. (U.S. EPA 1982b).

Drinking Water. Ground and surface water supplies were evaluated as potential routes of exposure to chemicals from the Taylor Site. Under existing usage patterns, neither of these

* This section has been adapted from the E&E Report (E&E, 1982b).

sources are likely routes of exposure to the local or down-stream human population by direct ingestion in drinking water or contact through other household uses.

Groundwater is not currently a source of drinking water in the vicinity--there is only one private well (abandoned)[2] within a mile of the site and most of the local population uses cisterns or is connected to municipal drinking water supplies.[3] The few homes adjacent to the site on Letts Road use water from cisterns. The principal reason for the minimal use of both the shallow water-bearing formations and deep aquifers in the area is their generally poor yield and quality. As discussed in detail in an earlier section, recharge rates in wells established in the shale are very slow and the pumping rate of the well established in the deep limestone aquifer was only four gpm (E&E, 1982a). Natural concentrations of manganese and iron in the groundwater of the shallow water-bearing formation already exceed National Secondary Drinking Water Standards (E&E, 1982c). Similarly, groundwater in the deep aquifer contains concentrations of chlorides (1300 mg/l) that exceed the National Secondary Drinking Water Standards (250 mg/l) by a factor of 5.

A second factor limiting potential future human exposure to contaminants via groundwater is the limited population growth expected in the vicinity of the A.L. Taylor Site (E&E, 1982b). The population is expected to increase slightly because of the

2. The private well was never used because of its low yield.
3. Personal Communication. Shane Hitchcock, U.S. EPA.Region IV, June 7, 1984, July 11, 1984.

area's accessibility to Louisville, but topographic features of the area surrounding the A.L. Taylor Site make it largely undevelopable (KIPDA, 1978, Vol. 2 in E&E, 1982b). The population pressures would therefore be relatively unlikely to increase demand for use of the aquifer in the near vicinity of the A.L. Taylor Site.

Geohydrologic studies of the site, although incomplete, suggest that transport of contaminants laterally off site or vertically down into the confined limestone aquifier is likely to be very slow. The annual groundwater recharge is calculated to be low and, assuming the fastest rate of groundwater flow projected (2 feet/yr) and no attenuation of contaminants in the silty clay, the contaminant plume might take 20 years to progress 50 feet.

Limited data from borings and monitoring wells on the site indicate that up to 85 feet of unweathered shale may isolate the limestone aquifer from the contaminated overburden. However, because of the large uncertainties inherent even in good hydrologic investigations, these routes of transport cannot be completely dismissed. There is already conflicting evidence on current contamination of the deep limestone aquifer.

Like groundwater, surface water is not used as a drinking water source downstream of Wilson Creek and the A.L. Taylor Site. The only drinking water intakes downstream and nearby are those for Louisville, but they are located upstream of the Salt River's confluence with the Ohio.[4] Even if water is withdrawn

for drinking from the Ohio River further downstream, the concentrations of A.L. Taylor Site contaminants are unlikely to exceed drinking water standards. The volumetric flow rate of the Ohio River at Louisville is approximately 114,000 cubic feet per second (cfs)(Bell, 1966 in E&E, 1982b), but the volumetric flow rate of Wilson Creek is only about 0.1 cfs (E&E, 1982b). Concentrations of contaminants found in Wilson Creek, even in 1979, were not high enough to create a public health or environmental hazard after such a million fold dilution.

Recreational Use of Surface Water. Other potential routes of exposure via surface waters include direct contact during ingestion of fish or swimming in surface waters contaminated by A.L. Taylor Site chemicals. Little information is available on either of these activities downstream of the A.L. Taylor Site.

The Department of Fish and Wildlife noted that the rivers leading from Wilson Creek are not considered fisheries except perhaps as habitats for darters or minnows. Salt River at its confluence with the Ohio is the first river that might be considered a fisheries area.[5]

No information was available on swimming in rivers downstream of the A.L. Taylor Site so it may be considered a potential route of exposure. However, the concentrations of contaminants encountered from the A.L. Taylor Site are likely to

4. Personal Communications, David Leigh, Water Program, State of Kentucky, June 19, 1984.
5. Personal Communications, Ted Crowell, Assistant Director of Fisheries, U.S. Fish and Wildlife, Kentucky, June 19, 1984.

be very low given probable levels of discharge of contaminants from the site to Wilson Creek.

Air. There are two major potential routes of exposure to chemicals in air: inhalation of volatilized components and inhalation of contaminated particulates entrained in the air. Both routes have been evaluated for persons entering the site and for offsite populations. Because no air monitoring has been conducted for the site, these evaluations have been based largely on assessment of the likely environmental transport and fate of contaminants most commonly found at the site.

Inhalation of volatile contaminants from the site is unlikely to be a major route of exposure either for the individuals entering the site or for offsite populations. In order to have high levels of organic vapors in the air above the site, volatile compounds must both be present in the soil in sufficient quantities and be exposed to the air. While several volatile compounds were detected at the site, they were primarily found underground or in groundwater. Evaluation of the sampling data shows that even in 1979, the major contaminants of surface soils (within the top 2 feet) were the higher molecular weight, low volatility compounds like napthalene, the phthalates, anthracene/phenanthrene, pyrene, flouranthane and xylene (see Table 2-3). The tendency of these compounds to adsorb strongly to the type of silty-clay soil found at the Taylor Site further slows their transfer to air (U.S. EPA 1979d).

Some loss of compounds from the soil to the air is inevitable, especially during the warmer months. However, slow rate of release combined with substantial dilution in air on a large open site are likely to result in very low concentrations to persons on-site or in nearby residential areas. The above conditions do not preclude the possibility that a person or natural erosion might disturb the site surface sufficiently to expose pockets of contaminants or buried drums that could result in acute exposures. Substantial quantities of buried wastes are reported to remain on site and access to the site is essentially unrestricted.

The more plausible route of exposure from airborne contaminants on the site is inhalation of airborne particulate matter containing low volatility compounds and metals. As discussed in the section on site contamination, surface soils have been found to contain a variety of organic compounds and elevated levels of barium, chromium, copper, nickel, lead and zinc. The sparse vegetation and heavy erosion observed in parts of the site increase the probability of entrainment of exposed soil in air. Human activity on the site, such as use of trail or mini-bikes, could help entrain contaminated dust in air.

Direct Contact With Contaminated Soils or Wastes. A final route of exposure that must be considered is direct contact with contaminated soils or wastes. Substantial quantities of wastes are believed to remain in covered trenches throughout the site. Some waste remains in an open pit at one western edge of the

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storage area and trenches partially filled with runoff from the site still line the eastern boundary of the site.[6] These areas of the site are freely accessible and potentially inviting playgrounds for local children and/or adults. Erosion at the site had partially exposed a barrel of unknown content. Direct contact with concentrated wastes stored at the site could result in serious exposures.

Environmental Exposure

An extensive description of the biotic resources found in the vicinity of the A.L. Taylor Site is provided in Chapter 3 of the Feasibility Study of Remedial Alternatives for the A.L. Taylor Site written by E&E (E&E, 1982b). In addition to the physical description of the site, the chapter discusses the surface and groundwater resources, terrestrial and aquatic biology, and threatened and endangered species as listed both federally and by the State of Kentucky. Field sampling for aquatic invertebrates and fish was conducted in Wilson Creek and in rivers downstream in 1979. The fish species identified in streams near the A.L. Taylor Site are listed in Table 2-7. These species are typical of small upland freshwater streams. The diversity of species found particularly in Wilson Creek and Pond Creek is indicative of a generally healthy, non-stressed population.

The contaminant fate and transport assessment showed that the principal mechanism for transport of contaminants from the

6. Site Visit, M&E, KDNREP, EPA, September 1983.

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TABLE 2-7
FISHES OCCURRING IN THE VICINITY OF
THE A. L. TAYLOR SITE 1979)

FAMILY	SCIENTIFIC NAME	COMMON NAME	NUMBER COLLECTED
	Wilson Creek (Mile 2.8)		
Cyprinidae	Phoxinus erythrogaster	Red belly Dace	1
	Campostoma anomalum	Stoneroller	1
	Pimephales notatus	Bluntnose minnow	6
	Semotilus notatus	Creek Chub	26
Percidae	Etheostoma nigrum	Johnny darter	2
	Wilson Creek (Mile 1.2 - 1.3)		
Catostomidae	Catostomus commersoni	White sucker	6
Esocidae	Esox americanus	Grass pickerel	1
Cyprinidae	Semotilus atromaculatus	Creek chub	61
	Phoxinus erythrogaster	Redbelly dace	1
	Pimephales notatus	Bluntnose minnow	7
	Pimephales promelas	Fathead minnow	1
Ictaluridae	Ictaluras melas	Black bullhead	1
Centrarchidae	Lepomis cyanellus	Green sunfish	9
	Lepomis macrochirus	Bluegill	4
	Southern Ditch (Mile .6 - 1.0)		
Cyprinidae	Pimephales promelas	Fathead minnow	5
Centrarchidae	Lepomis cyanellus	Green sunfish	9
	Lepomis macrochirus	Bluegill sunfish	1
	Pond Creek (Mile 7.8 - 7.9)		
Cyprinidae	Pimephales promelas	Fathead minnow	2
	Carassius auratus	Goldfish	2
	Notropis atherinoides	Emerald shiner	28
Ictaluridae	Ictalurus melas	Black bullhead	2
Poeciliidae	Gambusia affinis	Mosquitofish	2
Centrachidae	Lepomis macrochirus	Bluegill	7
	Lepomis cyanellus	Green sunfish	23

Source: KDNREP, 1979 in E&E, 1982b.

A.L. Taylor Site is by surface runoff. Contaminants may be transported as dissolved or sediment-sorbed constituents of runoff. Sampling of runoff water and sediments in 1982 indicated contamination by several organic compounds and by a few metals at concentrations above background. The principal area of discharge for this runoff is Wilson Creek. The biota of Wilson Creek and downstream creeks including Southern Ditch, Pond Creek, the Salt River and finally the Ohio River, are the principal offsite environmental receptors at this site.

Other possible but less likely receptors include wildlife and vegetation which may be exposed via airborne contaminants, and vegetation, wildlife, and domestic animals which may come in direct contact with soils, leachate, and surface runoff at the site itself. Airborne exposure is not considered to be significant based on the conclusion of the environmental fate and transport evaluation that surface-to-air transport of contaminants is minimal. Exposure via direct contact cannot be quantified as there are no available data regarding entry onto the site by domestic and wild animals, but it is expected that animals will avoid the area as there are no substantial food sources, i.e., vegetation, available at the site. Destruction of vegetation by contaminated runoff has not been documented at this site.

The principal means of environmental exposure from the Taylor Site, therefore, is by discharge of contaminated runoff to Wilson Creek, if the site remains unaltered from its present condition. The principal receptors are the fish populations of Wilson Creek and other downstream creeks.

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2.5 TOXICOLOGICAL PROPERTIES

Public Health. This section summarizes the toxicological properties of the major compounds found at the Taylor Site. Because of the predominance of exposures resulting from activity on site (soil contact or inhalation), the evaluation has focused on compounds found in high concentrations in surface soils, in runoff water and in disposal pits; the phthalates, napthalene, xylene, ethyl benzene, anthracene, lead, nickel, chromium, zinc, manganese, copper and aluminum. Although not present in high quantities, PCBs have been discussed briefly. Particular attention has been given to dermal absorption and toxicity for each compound.

The phthalates are in general not acutely toxic, but have been associated with several serious chronic effects in test animals. Bis (2-ethylhexyl) phthalate (DEHP) has been associated with cancer in laboratory animals and it is mutagenic in both Salmonella test systems and in the dominant lethal assay in mice. It has been found to be teratogenic in mice when administered intraperitoneally and has been associated with adverse reproductive effects in both female and male mice. DEHP's teratogenic effects have been found at relatively high doses (1/10 to 1/3 of the 50 LD) and are highly dose-dependent (Casarett & Doull, 1980). Di-n-octyl phthalate (DNP) has been tentatively associated with toxic polyneuritis in workers primarily exposed to DNP. Although it has been associated with adverse reproductive effects, it has not been found to be

mutagenic, teratogenic or carcinogenic (EPA, 1980a). Both DEHP and DNP are primarily absorbed in the intestine although small amounts (6-20% of exposure) may be absorbed through the skin (EPA, 1980a).

Napthalene has primarily been shown to cause cataracts (similar to those occurring in old age) in several animal species and in fish when ingested or inhaled in high concentrations. Rabbits fed one gram per kilogram body weight per day by the oral route developed cataracts (Casarett & Doull, 1980). Napthalene can be transferred across the placenta and cause retinal damage to developing embryos. Chronic exposure has been also associated with hemolytic anemia and occasionally renal disease in newborn infants, children and adults after exposure (extent and duration not given) to napthalene by ingestion, inhalation and, possibly, skin contact (USEPA, 1980a).

Xylene has been reported to have teratogenic and reproductive effects in animal models. When inhaled in the volatile phase, xylene may also be acutely toxic causing lung irritation which can lead to pulmonary adema (Casarett & Doull, 1980).

Anthracenes, ethyl benzene, and PCBs have been reported to irritate the skin. Anthracenes as a class are known experimentally to cause local inflammation rapidly in human skin when applied directly (Casarett and Doull, 1980). Prolonged occupational exposure to ethyl benzene has been associated with skin rash. Extended skin contact with PCB fumes or cold wax may

cause chloracne (characterized by sebaceous cysts and pustules). Both ethyl benzene and PCBs may also cause irritation to the eyes, nose and throat (USDHEW, 1977).

Ethyl benzene and PCBs are also associated with other forms of acute and chronic toxicity. High vapor concentrations of ethyl benzene can cause narcosis (weakness, dizziness). Acute and chronic exposure to PCBs may cause damage to the liver and case studies of accidental oral intake have shown PCBs to be embryotoxic (USDHEW, 1979). Polychlorinated biphenyls have also been associated with liver cancer in laboratory animals, but their carcinogenicity may partly be attributable to trace contamination by halogenated benzopyrenes and benzofurans (Casarett and Doull, 1980).

For metals, the chemical form is a major determinant of both absorption characteristics and toxicity. Hexavalent (+6) chromium for instance, has been associated with cancer and other chronic effects while the trivalent (+3) state has not. Unfortunately, none of the sampling results from the Taylor Site reported the chemical form of the metals detected making assessment of the public health and environmental impact of metal contamination difficult at best. Therefore, the following discussion of metals toxicity has not been restricted to particular chemical forms.

The human health effects of lead have been well documented relative to other compounds. High exposures to lead have been associated with encephalopathy, a sometimes fatal effect on the

central nervous system. Low exposures have been shown to have subchronic effects on the nervous system, the implications of which are not yet fully understood. Low lead exposures have been associated with subtle behavioral effects in children and with slowing of nerve condition velocity (with no impairment of muscular activity) in adults.

The major routes of exposure to lead at the Taylor Site are likely to be inhalation and subsequent swallowing of contaminated particulate matter or for young children, direct ingestion. Inorganic forms of lead which are the most likely form to be encountered at the site are not readily absorbed through the lungs and skin.

Nickel, chromium, zinc and barium have each been associated with toxic effects on the skin. Hexavalent chromium is a strong sensitizing agent. Chronic occupational exposure to hexavalent chromium compounds has been consequently shown to cause contact dermatitis. Allergic responses to nickel are also believed to be responsible for the contact dermatitis, associated with exposures to nickel sulfate. Constant handling of zinc salts has also been associated with dermatitis and barium oxide, barium sulfides and barium carbonate fumes and dusts are reported to cause irritation of the eyes, nose and throat (U.S. EPA, 1980a).

Epidemiologic studies have shown both nickel and hexavalent chromium to be carcinogenic in man when inhaled but the evidence for carcinogenicity via the oral route is unclear.

Studies in mice and rats have found hexavalent chromium, but not nickel, to be carcinogenic via the oral route. Nickel exerts toxic effects primarily via inhalation rather by ingestion; chronic inhalation of nickel can lead to irritation and injury of the upper and lower respiratory tract (U.S. EPA, 1980a; Casarett and Doull, 1980).

Zinc has been associated with systemic effects in animals when ingested in sufficient quantities. Rats fed greater than 0.25% zinc in their diet exhibited growth retardation, subchronic anemia, and defective mineralization of bone. Zinc has also been found to cause testicular tumors in rats and chickens when injected intratesticularly (Casarett & Doull, 1980).

Soluble salts of barium can be acutely toxic if ingested (EPA, 1980a). Barium chloride taken orally can produce severe abdominal pain and possibly death in humans at amounts as low as 800-900 mg (550-500 mg Barium) (U.S. EPA, 1980a).

Manganese toxicity has been most clearly described in relation to inhalation exposure found in manganese oxide mining or manufacturing. Acute exposures have been reported to lead to manganese pneumonitis, on irritation/inflammation of the lungs. Chronic exposures, generally greater than two years in duration, have been associated with a central nervous system disorder closely resembling Parkinson's Disease.

Copper and aluminum demonstrate relatively low levels of acute or chronic toxicity. Copper has not been associated with any acute or chronic effects in occupational settings (EPA,

of buried wastes are believed to remain on site; erosion at the site has exposed one barrel and soil samples in 1982 indicate that contamination remains in surface soils.

Other routes of exposure through groundwater, surface water, and air (volatile compounds) are less likely to pose risks to human health. Exposure via use of groundwater for drinking, bathing or other household applications is unlikely given current projected future use of groundwater in the area, and the apparent rate of contaminant transport through geologic formations at the site.

Current use of the groundwater from either the upper water-bearing formations and the lower confined limestone aquifer is low because of the poor natural quality and yield of water.

Many residents of this area of Bullitt County, including the adjacent golf course, are already served by the Louisville Water Company.[7]

Projected future use of these groundwater sources is low, but not necessarily impossible. Both the quality and yield of groundwater in the area is poor. Groundwater in both the upper geologic formations and in the deep limestone contained chloride concentrations which were five times greater than the National Secondary Drinking Water Standard. Iron and manganese concentrations also exceed drinking water standards. These factors combine to make groundwater in the vicinity of the site a

7. Personal Communication, Louisville Water Co., June 25, 1984.

less attractive source of drinking water, although they do not preclude possible attempts to use it in the future.

Even assuming future use of groundwater near the A.L. Taylor site, studies of the site, although incomplete, suggest that transport of contaminants laterally off site or vertically down into the confined limestone aquifer is likely to be very slow. Assuming the fastest rate of groundwater flow projected (2.4 feet/yr) and no attenuation of contaminants in the silty clay, the contaminant plume might take 20 years to progress 50 feet. Limited data from borings and monitoring wells on the site indicates that up to 85-100 feet of unweathered shale may isolate the limestone aquifer from the contaminated overburden. However, because of the large uncertainties inherent even in good hydrogeologic investigations, these routes of transport cannot be completely dismissed.

Surface water is also an unlikely major route of exposure because it is not known to be used for drinking water. Under some conditions, flow in Wilson Creek dries up completely. Also, although surface runoff and groundwater are expected to continue to contribute contaminants to Wilson Creek, limited sampling data indicates that the resulting concentrations are unlikely to pose a substantial risk to public health. Wilson Creek and downstream locations were last sampled in February 1979 before any site cleanup. Although several thousand micrograms per liter of a few compounds (methyl ethyl ketone, methyl isobutyl ketone) were found in sampling locations directly downstream of the A.L.

Taylor Site, concentrations of organic compounds further downstream in Southern Ditch and Pond Creek were reported to be "low" or "very low"[8] in both water colums and sediments (< 5 mg/kg) (U.S. EPA, 1979a). Comparable levels of contaminants were found in Southern Ditch both upstream and downstream of its confluence with Wilson Creek. These data suggest that the surface water system into which Wilson Creek flows is already contaminated and that Wilson Creek, even in 1979, was not substantially increasing contaminant levels above upstream concentrations. Concentrations in Wilson Creek, Southern Ditch, and Pond Creek are likely to be lower than 1979 levels now that most surface contamination has been removed from the site.

Contaminant issues aside, the surface water system downstream of Wilson Creek is not currently used as a drinking water supply except downstream of the Salt River's confluence with the Ohio River. The low levels of contaminants found in Southern Ditch and Pond Creek would be negligible once diluted in the flow of the Ohio River.

Organic vapors at the site are also unlikely to pose risks to the public health of on or offsite populations. Although no air monitoring data was generated to support this conclusion, the low volatility of the compounds left in surface soils on the Taylor Site make it unlikely that the compounds would be volatilized rapidly to air. Subsequent dilution of any contaminants released to the air in a large open site would

8. Actual values were not reported.

likely maintain concentrations at negligible levels both on and off site.

Although direct contact, inhalation, and ingestion of contaminated soils at the A.L. Taylor site are the most likely routes of exposure, their impact on public health is difficult to assess. Evaluation of the toxicological properties of the major compounds detected at the Taylor site indicates that chronic or subchronic effects are of greater concern than acute effects.

Assuming no substantial disturbance of the site, the risk of acute effects from exposure to existing concentrations of chemicals is likely to be low. The acute irritant effects of xylene on the lungs or narcotic effects of ethyl benzene are associated with inhalation or ingestion of high concentrations of these compounds. High vapor concentrations are unlikely given the volume and volatility of the major contaminants found in surface soils and were not reported on a recent visit to the site by M&E, EPA and KDNREP representatives.

The risk of acute exposures is greater if natural erosion or human activity at the site increases access to wastes or drums buried at the site. Contact with more concentrated wastes would then be possible. Erosion has already partly exposed one of the barrels originally buried at the site.[9]

Chronic exposures to individuals from repeated entry and activity on the site may be more serious. Although most of the health effects of componunds at the site have been primarily

9. Site Visit, M&E, KDNREP, September, 1983.

associated with higher exposures generally encountered in industrial settings, subchronic effects have also been reported for some compounds. Low levels of lead exposure have been associated with subtle neurological changes in both adults and children. Sensitization to hexavalent chromium and nickel compounds, with subsequent irritation of skin and mucous membranes, generally take place after chronic exposures to these compounds. Bis (2-ethylhexyl) phthalate, hexavalent chromium, nickel and PCBs have been associated with cancer (DEHP and PCBs in animals and chromium and nickel in humans). Since cancer is believed to act by mechanisms that have no biological threshhold, any exposure to carcinogens increases the risk of developing cancer. Because of the possibility of concurrent exposures at the A.L. Taylor site to multiple compounds with toxic and carcinogenic effects, the overall risks of adverse effects to individuals entering the site are likely to be higher than the risks of exposure to any one compound alone.

Environmental Risk. Water column and sediment samples in Wilson Creek, Southern Ditch and Pond Creek were taken in 1979. The water column data for Wilson Creek are presented in Table 2-6, and the compounds detected in Wilson Creek stream sediments and other locations are discussed in Section 2-2. Actual measured concentrations were provided only for Wilson Creek samples, and the remaining streams are discussed semi-quantitatively. The 1979 EPA data were used in this assessment of environmental exposure and effects as they are the only

monitoring data available for streams in the vicinity of the A.L. Taylor Site.

The compounds detected in both water column and sediment samples were primarily volatile and semi-volatile organics, including alchohols, esters, acids, ketones, aliphatics, and aromatics. The data presented in Table 2-6 are a summary of those compounds found in Wilson Creek water samples in the highest concentrations. Of the compounds detected, in general, only those that are priority pollutants have been studied to assess their aquatic toxicity. No aquatic effects were found for any of the compounds detected in Wilson Creek water or sediment samples, with the exception of trans-1,2-dichloroethylene and PCBs, Arochlors 1254 and 1260. The EPA Ambient Water Quality Criteria for the protection of fresh water aquatic life (Federal Register Vol 45, No. 231, Friday November 28, 1980) for trans-1,2-dichloroethylene is 11,600 ug/l (acute toxicity). No chronic toxicity data for this compound were available. The concentrations detected at both stations fell below the water quality criteria by a factor greater than 100. Therefore, the concentrations of trans-1,2-dichloroethylene found in Wilson Creek in 1979 would not be likely to have an adverse impact on stream biota.

The Pond Creek stations appear to be the farthest point downstream in the Salt River drainage basin where compounds originating from the A.L. Taylor Site have been detected. Organic compounds were found in low concentrations in both water

column and sediment samples. No PCBs were detected in water column samples, but Arochlor 1254 and 1260 were detected in all 4 Wilson Creek sediment samples (see Table 2-6). PCBs were also detected on Pond Creek in February 1979 at concentrations of 0.018 and 0.047 mg/kg at two locations. The ambient water quality criteria for PCBs is for aqueous concentrations and therefore does not aid in the evaluation of sediment concentrations. The principle aquatic impact of PCBs in the sediments would most likely occur by uptake and bioaccumulation of PCBs by bottom feeding organisms.

The assessment of overall environmental impacts on Wilson Creek must be based on 1979 data for both fish populations present and contaminant concentrations found. Based on the fish species identified, the populations in Wilson Creek and Pond Creek appear to be diverse, and typical of these types of streams. The contaminants found in 1979 stream and sediment samples do not appear to have had an adverse impact on Wilson Creek and or on rivers downstream. Due to the absence of more recent sampling data, it is not possible to determine either what long-term impacts there may have been on biota, or what compounds are presently found in the steams. The continued input of contaminated solid and/or leachate via surface runoff to Wilson Creek may have an adverse impact on the streams and possible downstream biota, but the nature and extent of that impact is not quantifiable given available data.

Welfare. In addition to potential public health impacts, the existence of the A.L. Taylor Site is likely to continue to have an adverse influence on property values in the vicinity. The site already appears to have limited development in the immediate area; the number of homes located along Letts Road which borders the southern side of the site has remained at five for the past 11 years (Aton, 1982 in E&E, 1982b). Although the emergency remedial measures undertaken in 1979 and 1981 have eliminated the obvious problems associated with the site (odor and unsightliness), the stigma of a hazardous waste site is likely to remain.

2.7 CONCLUSIONS

The A.L. Taylor Site remains a threat to public health, welfare and to the environment. Analysis of contamination at the site has shown that the site primarily poses a public health risk to persons entering and playing on the site. Inhalation and/or ingestion of contaminated soils and skin contact with contaminants are the likely primary routes of exposure. Continued erosion at the site increases the probability that more concentrated pockets of waste may be uncovered. Groundwater is not a likely route of exposure given the poor natural quality and yield of groundwater in the area and the availability of other sources of water supply. However, if groundwater in the vicinity of the A.L. Taylor site is considered in the future as a source of groundwater supply, additional risk assessment may be necessary.

Runoff from the site is also likely to continue to carry contaminants to Wilson Creek. Analysis of runoff samples in 1982 found contamination by both organic chemicals and by metals. Erosion of areas underlain by waste disposal pits could result in the discharge of high concentrations of contaminants to Wilson Creek.

The primary environmental impact of the site appears to be the continued degradation of Wilson Creek. Although biological sampling in 1979 indicated the presence of a normal, diverse population of organisms, continued input of contaminated soil and runoff to the stream may, over time, have an adverse impact on Wilson Creek biota.

Finally, the slow rate of housing development near the A.L. Taylor Site suggests that the site continues to discourage new development in the area despite removal of major evidence of surface contamination. Property values in the area are also likely to remain depressed. The site should not be permitted to be left in its current state. Final remedial action at the site should be completed to mitigate potential adverse impacts on public health, welfare, and the environment.

CHAPTER THREE

EVALUATION OF MODIFIED ON-SITE CONTAINMENT ALTERNATIVE

3.1 TECHNICAL EVALUATION

Background. Geosciences Research Associates, Inc. (GRA) and Tenech Environmental Engineers, Inc. (TEE) have proposed a modified on-site containment approach at the A.L. Taylor Site. This approach is based on work performed by Ecology and Environment, Inc. (E&E) during late 1981 and 1982, a water balance study done by TEE, and other applicable hydrologic and geologic reports. The alternative that GRA and TEE have proposed contains the following remedial technologies:

- Impermeable cap and soil cover
- Drainage diversion ditch
- Groundwater monitoring well system
- Site clearing, regrading, and revegetation
- Security fence and signs
- Record plot

Each of these items will be evaluated later in this Chapter according to the federal RCRA standards.

The following section will assess the effectiveness of the proposed modified alternative in terms of:

1) On-site groundwater containment
2) Prevention of infiltration
3) Long-term monitoring.

The results of this effectiveness assessment may be used in the future if groundwater contamination is detected off-site and if

groundwater in the vicinity of the site is considered as a source of water supply.

On-Site Groundwater Containment. The modified remedial Alternative proposed by the Potential Responsible Parties does not address the problem of containing any contamination leaving the Taylor Site through the groundwater system. The GRA investigation in 1984 determined permeabilities which could be used to calculate the flow through a cross-sectional area of the water bearing formation (i.e., the unconsolidated overburden materials). Based on a permeability ranging from 10^{-7} to 10^{-5} cm/sec, the groundwater flow was calculated to be 30 gallons/year to 45,000 gallons/year (19,000 gallons/year based on an average permeability value of 1.4×10^{-5} cm/sec - See Appendix A). These calculations show that some amount of groundwater flows through the system. The proposed final cap and cover includes no measures to prevent upgradient offsite groundwater from flowing underneath the site or to prevent any contaminated groundwater from leaving the site.

The permeabilities can also be used in calculating the flow velocity for groundwater movement through the site. Using the same permeabilities in previous calculations, the flow velocity ranges from .003 ft/yr. to 5.7 ft/yr. Although these flow velocities appear to be low, there still appears to be some groundwater flow across the downgradient boundaries. It should be noted that the flow velocity calculations are based on average permeabilities and that there may be zones of higher permeability

which would allow groundwater or contaminants to flow at higher rates than that shown above.

Prevention of Infiltration. The proposed cap for the A.L. Taylor Site was to consist of 24 inches of compacted cover material (6 inches of present soil compacted plus 18 inches of additional compacted cover material) meeting engineering specifications and 6 inches of top soil. Although it appears that the proposed cap will reduce rainfall infiltration on the site, TEE (1983) calculated a water balance based upon the proposed remedial actions which shows 60.5 mm (2.4 inches) of percolation per year. Assuming a surface area of approximately 192,000 square feet, this amount of percolation would result in 285,000 gallons of recharge to the unconsolidated overburden materials during one year of average rainfall. Using the highest value for groundwater flow offsite (45,000 gallons/year), there would be an extra 240,000 gallons of water percolating into the site, but unable to move through the upper water bearing formation (unconsolidated overburden material). Therefore, it is concluded that the proposed cap would not prevent rainfall infiltration from entering the groundwater system and creating additional leachate, based on the above calculations.

The proposed final cover and cap will prevent surface runoff from coming in contact with surface contamination presently on the A.L. Taylor Site. The further inclusion of an upgradient drainage diversion ditch, as proposed, will prevent any offsite surface run-on from flowing on site and will assist

in preventing excessive erosion and further infiltration of the cap. The drainage diversion ditch will channelize runoff upgradient from the site and divert it around the sides of the cover area and ultimately direct it towards Wilson Creek. The construction of the final cover and cap should essentially eliminate the contamination of any surface runoff flowing across the site.

Long-term Monitoring. Tenech (1983) proposed that seven monitoring wells be installed around the perimeter of the site. One well would be located upgradient of the site to monitor groundwater quality before it enters the site. The other six wells would be located downgradient of the site. These six wells would be located in groups of two with one well located outside the boundary. It was theorized that the on-site wells could detect pollutants before they migrate offsite so that further remedial measures could be implemented to prevent any further movement of the pollutants. The offsite wells would then be used to monitor the effectiveness of the implemented remedial measures. The one upgradient well would be drilled to a depth of 100 feet while the other six wells would be drilled only 30 feet deep.

The location of the wells appear to be adequate, but a few more pairs of wells on the downgradient side may be needed to insure that pollutant migration has not been missed. The shallow wells are designed to be screened only in the weathered shale. They should be constructed such that the screen extends through

both the overburden material and the weathered shale to insure that no contaminant migration is missed. There should be at least two shallow upgradient monitoring wells to be drilled to a similar depth as the downgradient monitoring wells and screened in the same geologic formation. It may be possible to include the two deep E&E monitoring wells as part of the A.L. Taylor monitoring well system. There appears to be no specific program describing how often the monitoring wells will be sampled and what type of laboratory testing will be required. The monitoring wells should be tested on a regular basis initially in order to develop a base of water quality data which may be compared with later tests. Once an adequate data base has been established, then the sampling frequency may be spread out over longer time intervals. Initial laboratory testing should be conducted for the major compounds detected onsite (volatiles, base/neutrals and metals) in order to insure that no important contaminants are overlooked. Additional volatile scans should also be conducted for other non-priority pollutants such as methyl ethyl ketone and methyl isobutyl ketone. Later testing may be targeted to specific chemical compounds which are judged to be representative of a contaminant plume leaving the A.L. Taylor Site. The monitoring well program should be conducted to insure that specific contaminant plumes can be identified and that appropriate remedial measures can be implemented before any contamination has migrated beyond the site boundaries.

CONFORMANCE WITH RCRA STANDARDS

Impermeable Cap and Soil Cover. Surface seals are often used during remedial action at contaminated sites to control infiltration, erosion, and direct contact with contaminants. Although the RCRA regulations do not apply to the Taylor Site, Part 264.310 of the regulations requires landfill owners or operators to cover the landfill upon final closure of the site. A few of the requirements in this citation are that the final cover be designed and constructed to function with minimum maintenance and have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

The cover TEE has proposed has a permeability of 10^{-6} cm/sec, or less. Laboratory permeability tests have been performed on the silty clay and weathered shale and values of about 10^{-8} cm/sec have been obtained. Therefore, the cover does not meet the RCRA standards in this regard.

Drainage Diversion Ditch/Trench. Drainage diversion ditches or trenches are commonly used at hazardous waste sites to control run-on and/or runoff. The RCRA regulations require that landfill owners or operators install a run-on control system capable of preventing flow onto the active portion of the facility during a peak discharge from at least a 25-year storm (40 CRF 264.301(c)). The regulations also require owners or operators of landfills to install a run-off management system that collects and controls the water volume resulting from a 24-

hour, 25-year storm (40 CFR 264.301(d)). The above RCRA requirements relate to facilities that are not closed. The main requirement for owners and operators of landfills that have gone through closure is that run-on and run-off be prevented from eroding or otherwise damaging the final cover (40 CFR 264.310(b)(5)). The drainage diversion trench proposed by TEE is designed to handle run-on/runoff from a 25-year storm. In this regard, it should also be sufficient for the post-closure requirement in 264.310(b)(5). Therefore, the proposed system appears to be in compliance with RCRA regulations.

Groundwater Monitoring Well System. Groundwater monitoring is often performed at hazardous waste sites to detect the offsite migration of any contaminants in groundwater. The RCRA regulations do not specify the number of groundwater monitoring wells required in Part 264 except that the groundwater monitoring system must consist of a sufficient number of wells, installed at appropriate locations and depths to yield representative samples (40 CFR 264.97(a)). The Interim Status regulations, Part 265, however, do specify that there must be at least one hydraulically upgradient monitoring well (265.91(a)(1)) and at least three hydraulically downgradient wells (265.91(a)(2)).

The number of wells proposed by TEE complies with the RCRA Interim Status regulations in Part 265. However, there is only one deep well on-site and this is located hydraulically

upgradient of the facility. There should be a deep well located hydraulically downgradient of the site.

Site Clearing, Regrading, and Revegetation. Regrading and revegetation are two common remedial action technologies that, in conjunction with a surface seal, control infiltration. Both technologies also provide long-term stability to surface seals. One of the post-closure requirements in the RCRA landfill regulations is that final covers on landfills must function with minimum maintenance (40 CFR 264.310(a)(2)). Proper grading minimizes the formation of "pools" of water on the landfill cover and appropriate vegetation will prevent erosion of the cap. Therefore, both technologies will minimize the amount of site maintenance. The methods proposed by TEE for clearing, regrading and revegetation at the Taylor Site do meet these RCRA requirements.

Security Fence and Signs. It is often necessary to prevent "knowing" and "unknowing" entry, and minimize the possibility for the unauthorized entry of persons or livestock onto the active portion of the facility (40 CFR 264.14) unless physical contact or disturbance of the waste does not injure unknowing or unauthorized persons or livestock.

The fence and signs by TEE will be sufficient to comply with applicable RCRA regulations.

Record Plat. It is often required that owners or operators of facilities that managed hazardous waste on their land notify the local land authority as to the extent of the

disposal area (40 CFR 264.1). Facility owners or operators are also often required to place a notation on the deed to the facility as to the past use of the land (40 CFR 264.120).

TEE's proposed record plat will provide enough information to the state concerning land use so that the facility will be in compliance with applicable RCRA regulations.

Other RCRA Requirements. One landfill closure requirement that TEE has not addressed in their modified on-site containment alternative is the use of a leachate collection and removal system. The RCRA requirements (40 CFR 264.310(b)(3)) specify that owners or operators of landfills must continue to operate the leachate collection system after closure until leachate is no longer detected.

3.2 PUBLIC HEALTH ASSESSMENT

The proposed remedial alternative would effectively reduce remaining threats to public health. The endangerment assessment has shown that greatest risk posed by contamination at the Taylor Site is to persons coming into direct contact with contaminated soils or buried wastes on site. The proposed cap would effectively limit further access to wastes and contaminated soils. Since the cap is also designed to reduce infiltration on site, it may also reduce the flow of water and thus transport of contaminants offsite and down to the deep limestone aquifer. The cap will also eliminate the surface transport of contaminants to Wilson Creek and rivers downstream.

In the endangerment assessment, several routes of human exposure to toxic chemicals were evaluated for the Taylor Site: drinking water and other household uses of groundwater and surface water supplies; airborne exposures to organic vapors or to contaminated particulate matter from the site; direct contact with contaminated soils or sludges and finally, exposure via ingestion of contaminated fish or by absorption during recreational use of surface waters contaminated by the Taylor Site. Each route of exposure was evaluated for both the likelihood and, where possible, the magnitude of the exposure. Persons entering the site were determined to be at greatest risk of adverse health effects because of the ease of access to the site and the high levels of organic chemicals and metals remaining in surface soil and in burial pits. The contaminants at the site have been associated with a variety of acute and chronic health effects in laboratory and in humans. Erosion at the site has partly exposed a buried barrel making the potential for acute exposures greater.

Other routes of exposure through groundwater, surface water, and air (volatile compounds) are less likely to pose major risks to human health. Exposure via use of groundwater for drinking, bathing or other household applications is unlikely given current and projected future use of groundwater in the area, and the apparent rate of contaminant transport through geologic formations at the site. Current use of the groundwater from either the upper water-bearing formations and the lower

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confined limestone aquifer is low because of the poor natural quality and yield of water. Many residents of this area of Bullitt County, including the adjacent golf course, are already served by the Louisville Water Company.[1]

Surface water is also an unlikely major route of exposure because it is not known to be used for drinking water. Also limited sampling data suggests that concentrations of organic compounds further downstream in Southern Ditch and Pond Creek were reported to be "low" or "very low"[2] in both water column and sediments (5 mg/kg) (U.S. EPA, 1979a).

Since contact, inhalation and ingestion of contaminated soils are the major route of exposure to chemicals at the site, the proposed cap would effectively reduce public health impact of the site.

3.3 ENVIRONMENTAL ASSESSMENT

The principal environmental impact associated with the no-action alternative, as identified by the Endangerment Assessment, is the transport of contaminants in surface runoff from the site to Wilson Creek and subsequently downstream. The placement of a cap over the site will eliminate this erosion and surface runoff problem and will, therefore, substantially reduce the expected environmental impacts due to the site. Data obtained from the groundwater monitoring wells can be used to assure that transport

1. Personal Communication. Louisville Water Co.; June, 1984.
2. Concentrations were not specified.

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offsite of contaminants is in fact not a significant environmental exposure pathway from this site.

3.4 CONCLUSIONS

M&E makes the following conclusions based on our technical evaluation, public health assessment and environmental assessment of the proposed modified containment alternative:

1. The infiltration through the proposed cap will be a source for leachate production and migration offsite in the overburden/weathered shale formation.
2. The proposed cap will prevent surface runoff contact with contaminated soil and the subsequent generation of contaminated runoff.
3. The proposed installation of upgradient diversion ditches will eliminate surface runon.
4. It is recommended that two or more upgradient monitoring wells be installed on the site. These wells would be drilled to a similar depth as the downgradient monitoring wells and be screened in the same geologic formation.
5. The shallow downgradient groundwater monitoring wells should be screened in both the overburden and weathered shale formations.
6. A groundwater monitoring sampling program should be established that includes the frequency and parameters of testing.

7. The proposed cover would not conform to RCRA standards, if applicable, that require the surfacecover to be at least as impermeable as any bottom liners or soils beneath the site.
8. The proposed modified containment alternative would not provide for a leachate collection and removal system, required by RCRA, that would operate until leachate is no longer detected.
9. The other components of TEE's proposed remedial alternative would comply with RCRA.
10. The proposed modified containment alternative would mitigate the threat to public health and the environment by eliminating the present routes of exposure. The proposed alternative may also mitigate the adverse impact of the site on public welfare.

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REFERENCES

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APPENDIX A

APPENDIX A

SUPPORTING GROUNDWATER, SURFACE RUNOFF AND RECHARGE CALCULATIONS

1. Groundwater Calculation:

   a. Vertical permeabilities from laboratory testing of soil samples (Geosciences Research Assoc., 1984)

      1.7×10^{-8} to 4.5×10^{-7} cm/sec

   b. Vertical permeabilities from laboratory testing of soil samples (Ecology & Environment, 1982b)

      4.75×10^{-8} to 2.2×10^{-7} cm/sec

   c. Combined horizontal and vertical permeabilities from field testing of monitoring wells (Goesciences Research Assoc., 1984)

      1.8×10^{-6} to 3.3×10^{-5} cm/sec

   d. Calculation for flow through cross-section of landfill:

      Assumptions:

      1. 500 foot width of aquifer
      2. 7 feet of saturated thickness
      3. hydraulic gradient: .03 to .07 (Ecology & Environment, 1982c)
      4. a. Permeability (minimum) = 1.7×10^{-8} cm/sec

         b. Permeability (maximum) = 3.3×10^{-5} cm/sec

         c. Permeability (average) = 1.4×10^{-5} cm/sec

   e. Calculations:

      $Q = KiA$ Q = discharge i = hydraulic gradient

      K = permeability A = cross-sectional area

Q(minimum) = 13.8 gal/yr (gradient = .03)

32.2 gal/yr (gradient = .07)

Av. = 23 gal/yr

Q(maximum) = 26,816 gal/yr (gradient = .03)

62,571 gal/yr (gradient = .07)

Av. = 44,693 gal/yr

Q(average) = 18,961 gal/yr (gradient = .05)

f. Calculation of flow velocity

Assumption: n=30% (.30)

$V = Ki/n$

V = velocity i = hydraulic gradient

K = permeability n = porosity

V(minimum) = 0.0018 ft/yr (gradient = .03)

0.0041 ft/yr (gradient = .07)

average = 0.003 ft/yr

V(maximum) = 3.41 ft/yr (gradient = .03)

7.97 ft/yr (gradient = .07)

average = 5.69 ft/yr

V(average) = 2.41 (gradient = .05)

2. Surface Runoff Calculations:

a. Assumptions:

1. Average rainfall = 43.11 inches (Tenech, 1983)
2. Surface area = (500 ft.)(1,000 ft.) = 500,000 $ft.^2$
3. Average runoff factor = 0.295 (Tenech, 1983)
4. Low runoff factor = 0.20

5. High runoff factor = 0.40

b. Calculation of runoff

Runoff (low) = 2,687,190 gal/yr

Runoff (high) = 5,374,380 gal/yr

3. Recharge calculation (from rainfall):

a. Assumptions:

1. average rainfall = 43.11 inches (Tenech, 1983)

2. Surface area = (480 ft.)(400 ft.) = 192,000 $ft.^2$ (Tenech, 1983)

3. a. infiltration factor (existing conditions) = .197 (Tenech, 1983)

b. infiltration factor (post closure) = .055 (Tenech, 1983)

b. Calculations:

recharge = (rainfall)(surface area)(infiltration factor)

recharge (a) = 1,016,403 gal/yr

recharge (b) = 283,767 gal/yr

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APPENDIX B

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APPENDIX B

UPDATED COSTS OF E&E's REMEDIAL ALTERNATIVES

Ecology and Environment, Inc. (E&E) proposed three remedial alternatives for the A. L. Taylor site in their September 1982 Feasibility Study. The construction cost estimates for the minimum action alternative, the onsite containment alternative, and the excavate-and-relocate alternative are presented in Tables B-1, B-2, and B-3, respectively. The costs have been updated to 1984 costs so that these alternatives can be compared to other alternatives. The factor used in updating the E&E costs from 1982 to 1984 is 1.07. This value is obtained from the ratio of the respective construction cost and building cost indices in the June 21, 1984 and September 23, 1982 Engineering News-Record Journals. The construction cost index in September 1982 was 3878 and in June 1984 was 4159. The building cost index was 2249 in September 1982 and 2416 in June 1984. The average of the two ratios is 1.07.

The present worth of the operation and maintenance (O&M) costs for the E&E alternatives are presented in Tables B-4, B-5, and B-6. The following assumptions have been made in determining the present worth operation and maintenance costs for the alternatives at the A.L. Taylor site:

TABLE B-1. UPDATE OF E&E CONSTRUCTION COST ESTIMATE FOR THE MINIMUM ACTION ALTERNATIVE

Item	Cost, Thousand Dollars 1982 Lower	1982 Upper	1984 Lower	1984 Upper
Pit and Surface Dumping:				
Excavation & Backfill	12.6	18.9	13.5	20.2
Transport & Disposal	51.7	79.5	55.3	85.1
Site Rehabilitation (Minor grading, fertilizing, trees, seeding & mulching)	4.0	5.0	4.3	5.4
Wastewater treatment renovation/ operation/disassembly*	26.8	68.6	28.7	73.4
Monitoring Wells	10.5	10.5	11.2	11.2
Security & Safety, Plat Survey & Legal Fees	2.0	3.0	2.1	3.2
Warning Signs	0.1	0.1	0.1	0.1
TOTAL	107.7	185.6	115.2	198.6

* The wastewater treatment system will be renovated so that the lagoon water can be treated. Once the lagoon water is treated, the system will be disassembled and shipped to the KDNREP.

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TABLE B-2. UPDATE OF E&E CONSTRUCTION COST ESTIMATE FOR THE ONSITE CONTAINMENT ALTERNATIVE

Item	Cost, Thousand Dollars 1982 Lower	1982 Upper	1984 Lower	1984 Upper
Slurry Wall	70	120	75	128
Clay Cap	52	102	56	109
Topsoil Cover	60	100	64	107
Drainage Diversion Channel	4	7	4	7
Monitoring Wells (1-up;3 down)	8	13	9	14
Leachate Collection System	43	72	46	77
Wastewater treatment renovation/ operation/disassembly	207	69	29	73
Site Grooming, Clearing, Grubbing & Initial Revegetation	4	7	4	7
Security Fence, Gate, Signs	28	46	30	49
Utilities Installation	1	1	1	1
Record Plat	3	4	3	4
Project Management, Monitoring, Sampling and Permitting	40	60	43	64
SUB-TOTAL	340	601	364	640
Undefined Details & Contingencies (20%)	68	120	73	128
TOTAL	408	721	437	768

TABLE B-3. UPDATE OF E&E CONSTRUCTION COST ESTIMATE FOR THE EXCAVATE-AND-RELOCATE ALTERNATIVE

Cost, Thousand Dollars	1982		1984	
Item	Lower	Upper	Lower	Upper
Agency Management	5	12	5	13
Project Management	15	32	16	34
Pre-Excavation Sampling and Permitting	29	29	31	31
Mobilization	17	17	18	19
Excavation	85	204	91	218
Pollution Control*	68	151	73	162
Backfilling & Topsoil	80	179	86	192
Closure	29	32	31	34
Utilities	1	1	1	1
SUBTOTAL	329	657	352	704
Undefined Details (10%)	33	66	35	70
Contingencies (10%)	33	66	35	70
SUBTOTAL	395	789	422	844
Transport & Disposal	1,000	3,300	1,070	3,531
TOTAL	1,395	4,089	1,492	4,375

* E&E has included the wastewater treatment costs in this item.

TABLE B-4. PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS-MINIMUM ACTION ALTERNATIVE

1. Sampling/analytical costs:	
P/A - 1st year - $18,000	$16,364
P/A - 4 years - $9,000/year = $28,530	
P/F - 1 year - $28,530	$25,936
P/A - 25 years - $6,000/year = $54,420	
P/F - 5 years - $54,420	$33,790
2. Replacement of Monitoring Wells	
P/F - 15 years - $18,200	$4,358
3. Well Maintenance and Rehabilitation	
P/A - 50% - 5 - $4,000	
P/F - 5, 10, 15, 20, 25 years - $4,000	$5,948
4. Cover and Cap Maintenance	
P/A - 30 years - $3,000	$28,280
	$114,676

1. Assume: 10% interest.

TABLE B-5. PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS-ONSITE CONTAINMENT ALTERNATIVES

1. Leachate management system*	
P/A - 30 years - $9,000/year	$ 84,834
2. Sampling/analytical costs:	
P/A - 1st year - $18,000	16,364
P/A - 4 years - $9,000/year = $28,530 P/A - 1 year - $28,530	25,936
P/A - 25 years - $6,000/year = $54,420 P/F - 5 years $54,420	33,790
3. Replacement of Monitoring Wells	
P/F - 15 years - $18,200	4,358
4. Well Maintenance and Rehabilitation	
P/A - 50% - 5- $4,000 P/F - 5, 10, 15, 20, 25 years - $4,000	5,948
5. Cover and Cap Maintenance	
P/A - 30 years - $3,000	28,280
6. Gas Monitoring	
P/A - 1 year - $12,000/year	10,900
7. Miscellaneous (utilities, surface water control maintenance)	
P/A - 30 years - $3,000/year	28,280
	$239,290

1. Assume: 10% interest

* The operation and maintenance costs for the leachate management system include depreciation costs for the leachate pump and storage tank, $1,200 per year, and the offsite shipment and disposal of 120 55 gallon drums of leachate per year at a cost of $65 per drum.

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TABLE B-6. PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS-EXCAVATE-AND-RELOCATE ALTERNATVE

1.	Sampling/analytical costs:	
	P/A - 1st year - $18,000	$16,364
	P/A - 4 years - $9,000/year = $28,530'	
	P/F - 1 year - $28,530	25,936
	P/A - 25 years - $6,000/year = $54,420	
	P/F - 5 years - $54,420	33,790
2.	Replacement of monitoring Wells	
	P/F - 15 years - $18,200	4,358
3.	Well Maintenance and Rehabilitation	
	P/A - 50% - 5 - $4,000	
	P/F - 5, 10, 15, 20, 25 years - $4,000	5,948
		$86,396

1. Assume: 10% interest

1. Four monitoring wells will be installed, three downgradient and one upgradient (E&E specification), and they will be sampled quarterly for the first year and semi-annually for the following 29 years.
2. The sampling and analytical costs for the first five years will be $4,500 per year. The sampling and analytical costs for the next 25 years will be $3,000 per year. The reduction in yearly costs occurs because analysis of all priority pollutants will be provided for the first five years and only targeted compounds will be analyzed for the next 25 years. The costs for the inspection/sampling include personnel and laboratory costs. It is assumed that the laboratory costs could be reduced by approximately 50 percent after five years by targeting individual contaminants.
3. All monitoring wells will be replaced after 15 years. The replacement costs are based on the original installation costs.
4. A program of well maintenance and rehabilitation will be implemented every five years to insure that the monitoring wells will provide representative samples and that the structural integrity of the well has not been compromised or tampered with.
5. Site inspection, maintenance, and sampling will be completed at the same time, whenever possible.

6. A program of topsoil maintenance will be implemented every two years to insure that the topsoil cap completely covers the site. Periodically, it may be necessary to fill in erosion channels, to add topsoil to areas where the topsoil appears to be thinning and to re-seed areas where vegetation has become sparse. Any sod that has been placed on the site will be mowed during the growing season.
7. The site will be monitored for hazardous gases. This will consist of 12 air samples the first year, three each quarter, at a cost of $1,000 per sample. It is also assumed, as E&E proposed, that the leachate collection system and the gas control system would be combined within a single network.
8. No cost escalation factors were used in determining final monitoring costs. It should be noted that if a cost escalation factor were used equal to the interest rate (10%), the long term monitoring costs of the minimum action alternative would be $332,200 instead of $114,676. Likewise, the cost for the onsite containment alternative and the excavate-and-relocate alternatives would be respectively, $704,000 and 242,200 instead of $239,290 and $86,396.

ALT 001 001242

APPENDIX C

METCALF & EDDY

APPENDIX C

COSTS ASSOCIATED WITH THE PRP CONSULTANT REMEDIAL ALTERNATIVE

The Potential Responsible Party (PRP) Consultants, Tenech Environmental Engineers and Geosciences Research Associates, recommended a modified onsite containment alternative to the U.S. EPA in September 1983. The alternative offered by the PRP consultants included the same elements (technologies) that the E&E onsite containment alternative contained except that the proposed slurry wall and leachate collection system were eliminated. The alternative proposed by the PRP consultants was based on hydrogeological observations made by several parties after the original E&E Feasibility Study.

The costs (1984 dollars) associated with the modified remedial alternative are presented in Table C-1. The unit costs used to calculate each technology cost are presented in estimate worksheets at the end of this section. The following sources of information were used to obtain the technology unit costs:

- Building Construction Cost Data 1982, Robert Snow Means Company, Inc., Kingston, MA, 1981.
- Handbook - Remedial Action at Waste Disposal Sites, prepared by JRB Associates, Inc. for EPA's Office of Research and Development, Cincinnati, Ohio, June 1982.

TABLE C-1. SUMMARY OF CONSTRUCTION COST ESTIMATE FOR PRP CONSULTANT REMEDIAL ALTERNATIVE

Technology	Cost
Site Clearing	$7,930
Renovation of Treatment System	$39,200
Processing Lagoon Water	$7,000
Removal of Renovated Treatment System	$9,800
Diversion Trench Installation	$39,875
Site Grading	$22,820
Monitoring Well System	$18,200
Site Cover and Cap	$313,150
Revegetation	$28,300
Security Fence and Signs	$40,600
Record Plat	$5,000
	$531,875

- Handbook for Evaluating Remedial Action Technology Plans, prepared by Arthur D. Little, Inc. for the EPA's Office of Research and development, Cincinnati, Ohio, August 1983.
- Focused Feasibility Study - The Wade Site - Chester, Pennsylvania, prepared by Metcalf & Eddy, Inc. for EPA's Office of Waste Programs Enforcement, Washington, D.C., March 1984.

Information on the PRP consultant remedial alternative was obtained from two documents:

1. Contract Documents for Remedial Actions at the A.L. Taylor Hazardous Waste Disposal Site, prepared by Tenech Environmental Engineers, Inc., September, 1983.
2. A Final Design Report for the A.L. Taylor Hazardous Waste Disposal Site, by Tenech Environmental Engineers, Inc., September, 1983.

Long term (30 years) monitoring costs for this remedial alternative are shown in Table C-2. These costs are based on RCRA post-closure standards which apply to hazardous waste facilities where the waste remains onsite after closure. A number of assumptions have been made in developing these costs, including:

1. The four monitoring wells will be sampled quarterly for the first year and semi-annually for the next 29 years.
2. The sampling and analytical costs for the first five years will be $4,500 per year. The sampling and analytical costs for the next 25 years will be $3,000 per year. The reduction in yearly costs occurs because analysis of all priority pollutants will be provided in the first five years, whereas over the remaining 25 years only targeted compounds will be

TABLE C-2. PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS - PRP CONSULTANT ALTERNATIVE

1.	Sampling/analytical costs:	
	P/A - 1st year - $18,000	$16,364
	P/A - 4 years - $9,000/year = $28,530	
	P/F - 1 year - $28,530	$25,936
	P/A - 25 years - $6,000/year = $54,420	
	P/F - 5 years - $54,420	$33,790
2.	Replacement of Monitoring Wells	
	P/F - 15 years - $18,200	$4,358
3.	Well Maintenance and Rehabilitation	
	P/A - 50% - 5 - $4,000	
	P/F - 5, 10, 15, 20, 25 years - $4,000	$5,948
4.	Cover and Cap Maintenance	
	P/A - 30 years - $3,000	$28,280
		$114,676

1. Assume: 10% interest

analyzed. The costs for the inspection/sampling include personnel and laboratory costs. It is assumed that the laboratory costs could be reduced by approximately 50 percent after five years by targeting individual contaminants.

3. All monitoring wells will be replaced after 15 years. The replacement costs are based on the original installation costs.

4. A program of well maintenance and rehabilitation will be implemented every five years to insure that the monitoring wells will provide representative samples

and that the structural integrity of the well has not been compromised or tampered with.

5. Site inspection, maintenance, and sampling will be completed at the same time, whenever possible.

6. A program of topsoil maintenance will be implemented every two years to insure that the topsoil cap completely covers the site. Periodically, it may be necessary to fill in erosion channels, to add topsoil to areas where the topsoil appears to be thinning and to re-seed areas where vegetation has become sparse. Any sod that has been placed on the site will be mowed during the growing season.

7. No cost escalation factors were used in determining final monitoring costs. It should be noted that if a cost escalation factor were used equal to the interest rate factor (10%), the long term monitoring costs would be $332,200 instead of $114,676, for the PRP consultant alternative.

ALT 001 001248

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO/TAG: Site Clearing

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$5,660
												SUBTOTAL	$5,660
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 850
				Engineering			5%						$ 285
				Contingency			15%						$ 850
				Indirects			5%						$ 285
				TOTAL									$7,930

M&E

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO/NOX: Site Clearing

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Clearing site; mowing,					5	A*	900		$4,500
				raking, etc.									
				Clearing site; removal					0.5	A	2,320		$1,160
				of light trees to 6"									
				diameter									
				SUBTOTAL									$5,660

A* = Acre(s)

ALT 001 00129

ALT 001 001250

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO/UNIT: Renovation of Treatment System

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$28,000
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 4,200
				Engineering			5%						$ 1,400
				Contingency			15%						$ 4,200
				Indirects			5%						$ 1,400
				TOTAL									$39,200

ALT 001 001251

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO / NOX: Renovation of Treatment System

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Removal of Activated					500	ft^3	2		$ 1,000
				Carbon & On-Site									
				Disposal									
				Decontamination of									$ 2,000
				Existing Equipment									
				Replacement of					-				$ 4,000
				Unusable Parts									
				Carbon Replacement					500	ft^3	40		$20,000
				Alum (flocculant),					-				$ 1,000
				Utilities, Misc.									
				SUBTOTAL									$28,000

ALT 001 001252

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO/NOS: Processing Lagoon Water

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$5,000
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 750
				Engineering			5%						$ 250
				Contingency			15%						$ 750
				Indirects			5%						$ 250
				TOTAL									$7,000

ALT 001 001253

M&E

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NFB | ACY | INDEX NO

BUILDING NO THIS: Processing Lagoon Water

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Operation of Waste-					-				$5,000
				water Treatment System									
				SUBTOTAL									$5,000

ALT 001 001254

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 1

PROJECT NO: 9349

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

WEB | ALT | INDEX NO

BUILDING NO/TAG: Removal of Existing Runoff Treatment

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Disassembling Existing									$7,000
				Runoff Treatment System									
				and Shipping to KDNREP									
				SUBTOTAL									$7,000
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$1,050
				Engineering			5%						$ 350
				Contingency			15%						$1,050
				Indirects			5%						$ 350
				TOTAL									$9,800

M&E

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | REV | INDEX NO

BUILDING NO / TASK: Diversion Trench Installation

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$28,475
				Site Services, Manpower, Health & Safety Equip., Etc.			15%						$ 4,275
				Engineering			5%						$ 1,425
				Contingency			15%						$ 4,275
				Indirects			5%						$ 1,425
				TOTAL									$39,875

ALT 001 001255

ALT 001 001256

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Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO AND NAME: Diversion Trench Installation

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Excavating Trench					900	yd^3	3.75		$ 3,375
				Trench preparation for					25,000	ft^2	0.35		$ 8,750
				rip rap and sod									
				Installation of rip rap					12,500	ft^2	0.80		$10,000
				Installation of sod					12,500	ft^2	0.40		$ 5,000
				Installation of fully					100	LF	13.50		$ 1,350
				bituminous coated,									
				corrugated steel									
				SUBTOTAL									$28,475

M&E

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 1

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | REV | INDEX NO

BUILDING NO/NOV: Site Grading

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				General site grading;					24,000	yd^2	0.68		$16,320
				3 passes with motor									
				grader plus rolling									
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 2,450
				Engineering			5%						$ 800
				Contingency			15%						$ 2,450
				Indirects			5%						$ 800
				TOTAL									$22,820

ALT 001 001257

ALT 001 00125

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

REV | ALT | INDEX NO

BUILDING NO/UNIT: Monitoring Well System (Groundwater)

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$13,000
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 1,950
				Engineering			5%						$ 650
				Contingency			15%						$ 1,950
				Indirects			5%						$ 650
				TOTAL									$18,200

ALT 001 001259

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO 'NOX: Monitoring Well System (Groundwater)

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Groundwater Monitoring					3		3,500		$10,500
				Wells-3 downgradient									
				30' deep, 4" ID,									
				Stainless Steel									
				Groundwater Monitoring					1		2,500		$ 2,500
				Well-1 upgradient									
				100' deep, 1.5" ID, PVC									
				SUBTOTAL									$13,000

ALT 001 001260

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

MEB | ALT | INDEX NO

BUILDING NO/TAG: Site Cover and Cap

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$223,750
				Site Services, Manpower, Health & Safety Equip., etc.			15%						$ 33,500
				Engineering			5%						$ 11,200
				Contingency			15%						$33,500
				Indirects			5%						$ 11,200
				TOTAL									$313,150

ALT 001 0012G1

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

BUILDING NO./NOS: Site Cover and Cap

ESTIMATE NO:

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Disking of uppermost					5	A*	3,250		$16,250
				six inches of soil									
				Compaction of in-place					5	A	1,300		$ 6,500
				disked soil									
				Placement of 18-inch					5	A	26,800		$134,000
				soil ($\leq 10^{-6}$ cm/sec.									
				permeability) cap;									
				includes compaction									
				Placement of 6-inch					5	A	13,400		$ 67,000
				topsoil cover									
				SUBTOTAL									$223,750
				A* = Acre(s)									

ALT 001 001262

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

LEV | ELY | INDEX NO

BUILDING NO/NOE: Revegetation

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$20,220
				Site Services, Manpower, Health & Safety Equip. etc.			15%						$ 3,030
				Engineering			5%						$ 1,010
				Contingency			15%						$ 3,030
				Indirects			5%						$ 1,010
				TOTAL									$28,300

M&E

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | REV | INDEX NO

BUILDING NO / NAME: Revegetation

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Fertilizer; 0-20-20					5	A*	405		$ 2,025
				applied at 450 lbs per									
				acre and 38-0-0, urea									
				form, applied at 250									
				lbs per acre									
				Application of the two					5	A	720		$ 3,600
				different seed mixtures									
				Mulching of seeded					5	A	2,700		$13,500
				areas									
				Slope protection					0.25	A	4,380		$ 1,095
				SUBTOTAL									$20,220
				A* = Acre(s)									

ALT 001

001263

ALT 001 00126C4

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO/UNIT: Security Fence and Signs

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$29,000
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 4,350
				Engineering			5%						$ 1,450
				Contingency			15%						$ 4,350
				Indirects			5%						$ 1,450
				TOTAL									$40,600

M&E

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

MES | ECY | INDEX NO

BUILDING NO / NOS: Security Fence and Signs

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				A 9 gage wire x 2 incl					2,300	LF	12		$27,600
				mesh x 72 inches high									
				fence plus 3 strands									
				of barbed wire									
				14-foot lockable,					2	Each	700		$ 1,400
				double leaf gate									
				SUBTOTAL									$29,000

ALT 001 00126

M&E

Metcalf & Eddy, Inc.
Engineers & Planners

ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 1

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO/NOV: Record Plat

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Documentation of Site					1	Each	4,000		$4,000
				History in a Record									
				Plat									
				Engineering			5%						$ 200
				Contingency			15%						$ 600
				Indirects			5%						$ 200
				TOTAL									$5,000

ALT 001 00126

ALT 001 001267

APPENDIX D

APPENDIX D

REMEDIAL ACTIONS USING THE RCRA STANDARDS AS A BENCHMARK

This section reviews the applicability of the RCRA standards, 40 CFR Parts 260-267, to remedial actions at the A.L. Taylor site. The RCRA standards do not apply to the A.L. Taylor site because the wastes were disposed of at the site prior to November 19, 1980. However, the RCRA standards do provide a benchmark for remedial actions involving the on-site storage, treatment, or disposal of hazardous wastes or the excavation and off-site shipment of the contaminated material.

In this section, two different alternatives, which would both comply with the RCRA standards, are presented along with their associated costs. The first alternative involves the construction of a "new" hazardous waste landfill that would comply with RCRA Part 264 standards. It should be noted that if the A.L. Taylor site were subject to the RCRA regulations, it would be considered an existing landfill and therefore a bottom liner and leachate collection and removal system would not be required [264.301(a)]. Because the PRP consultant alternative, presented in Appendix D, essentially complies with the RCRA standards as an existing facility, only the design of a "new" landfill will be considered here.

One of the requirements of the construction of a "new" hazardous waste landfill is that it contain a bottom liner [264.301(a)(1)]. A synthetic liner must be used as the bottom

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liner because of the regulatory requirement that wastes must be prevented from passing into the liner [264.301(a)(1)]. Additionally, if the on-site soils do not provide a foundation or base capable of providing support to the liner, a foundation will have to be installed [264.301(a)(1)(ii)].

A leachate collection and removal system must be operated at "new" landfills (even during post-closure) until leachate is no longer detected [264.310(b)(3)]. Therefore, all owners or operators of new landfills will have to install and operate a leachate collection and removal system until leachate is no longer detected (potentially up to 30 years after the facility has closed).

Owners and operators of "new" hazardous waste landfills have a choice between installing a double bottom liner or operating a groundwater monitoring program under Part 264 Subpart F along with a single bottom liner. The groundwater monitoring, one bottom liner option is the only one considered in the "new" hazardous waste landfill alternative.

The specific technologies that would be included in a "new" RCRA landfill are listed in Table D-1 along with their respective costs. Many of the technologies necessary for the construction of the RCRA landfill were also included in the PRP consultant alternative. In addition, some of the technology items have the same design dimensions. For these items, estimating worksheets are not included in this appendix.

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TABLE D-1. SUMMARY OF CONSTRUCTION COST ESTIMATE FOR A NEW RCRA LANDFILL

Technology	Cost
Site Clearing	$7,930
Renovation of Treatment System	$39,200
Processing Lagoon Water	$7,000
Removal of Renovated Treatment System	$9,800
Excavation and On-Site Storage of Site Soils	$420,000
Diversion Trench Installation	$39,875
Bottom Liner and Leachate Control	$234,080
Monitoring Well System	$25,200
Site Cover and Cap	$573,525
Revegetation	$21,500
Security Fence and Signs	$40,000
Record Plat	$5,000
	$1,423,110

The same sources that were used to determine technology unit costs in Appendix C were also used for unit cost determination in this section.

Long term (30 years) monitoring costs for the RCRA landfill are presented in Table D-2. These costs are based on RCRA post-closure standards, which apply to hazardous waste facilities, where the waste remains onsite after closure. A number of assumptions have been made in developing these costs and those that are different from Appendix C include:

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TABLE D-2. PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS - RCRA LANDFILL

1.	Leachate Management System*	
	P/A - 30 years - $9,000/year	$84,834
2.	Sampling/analytical costs:	
	P/A - 1st year - $26,000	$23,636
	P/A - 4 years - $13,000/year = $41,207	
	P/F - 1 year - $41,207	$37,460
	P/A - 25 years - $8,600/year = $78,000	
	P/F - 5 years - $78,000	$48,431
3.	Replacement of Monitoring Wells	
	P/F - 15 years - $27,300	$6,535
4.	Well Maintenance and Rehabilitation	
	P/A - 50% - 5 - $6,000	
	P/F - 5, 10, 15, 20, 25 years - $6,000	$8,900
5.	Cover and Cap Maintenance	
	P/A - 30 years - $3,000/year	$28,280
6.	Gas Monitoring	
	P/A - First year - $12,000/year	$10,900
7.	Miscellaneous (utilities, surface water control maintenance)	
	P/A - 30 years - $3,000/year	$28,280
		$277,276

1. Assume: 10% interest.

* The operation and maintenance costs for the leachate management system include depreciation costs for the leachate pump and storage tank, $1,200, and the offsite shipment and disposal of 120 55 gallon drums of leachate per year at a cost of $65 per drum.

1. The use of six groundwater monitoring wells, two upgradient and four downgradient, which will be sampled quarterly for the first year and semi-annually for the next 29 years.
2. The sampling and analytical costs for the first five years will be $6,500 and $4,300 for the following 25 years.

The assumption of not using a cost escalation factor in the present worth calculation of long term monitoring costs also applies to this alternative. If a cost escalation factor equal to the assumed interest rate (10%) were used, the long term monitoring costs would be $812,300 instead of $277,276.

The second alternative presented in this section involves the excavation of the on-site material with the subsequent shipment of this material to a RCRA hazardous waste landfill. Another source to use in the selection of a commercial landfill is the list of hazardous waste landfills that can receive material contaminated with PCB's. Two of these landfills are located relatively close to the A. L. Taylor site; the Waste Management facility in Emelle, Alabama and the CECOS facility in Williamsburg, Ohio.

A summary of the costs associated with the excavation and off-site disposal, in each of the above sites, of material from the A. L. Taylor site is presented in Table D-3. The estimating worksheets that correspond to these costs are included after the estimating worksheets for the RCRA landfill.

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TABLE D-3. SUMMARY OF SOIL EXCAVATION AND DISPOSAL OPTIONS IN A RCRA LANDFILL

Soil Removal Option #1:	
The excavation of 31,700 yd^3 of material from the A. L. Taylor site with the transport of this material to CECOS International, Williamsburg, Ohio and disposal of this material at the site.	$4,359,425
Soil Removal Option #2:	
The excavation of 31,700 yd^3 of material from the A. L. Taylor site with the transport of this material to Waste Management, Inc., Emelle, Alabama and disposal of this material at the site.	$5,497,285

There are no long term monitoring costs associated with this alternative.

TABLE D-2. PRESENT WORTH CALCULATION[1] OF THE LONG TERM MONITORING COSTS - RCRA LANDFILL

1. Sampling/analytical costs:	
P/A - 1st year - $26,000	$23,636
P/A - 4 years - $13,000/year = $41,207	
P/F - 1 year - $41,207	$37,460
P/A - 25 years - $8,600/year = $78,000	
P/F - 5 years - $78,000	$48,431
2. Replacement of Monitoring Wells	
P/F - 15 years - $27,300	$6,535
3. Well Maintenance and Rehabilitation	
P/A - 50% - 5 - $6,000	
P/F - 5, 10, 15, 20, 25 years - $6,000	$8,900
4. Cover and Cap Maintenance	
P/A - 30 years - $3,000/year	$28,280
	$153,262

1. Assume: 10% interest.

1. The use of six groundwater monitoring wells, two upgradient and four downgradient, which will be sampled quarterly for the first year and semi-annually for the next 29 years.
2. The sampling and analytical costs for the first five years will be $6,500 and $4,300 for the following 25 years.

The assumption of not using a cost escalation factor in the present worth calculation of long term monitoring costs also applies to this alternative. If a cost escalation factor equal

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to the assumed interest rate (10%) were used, the long term monitoring costs would be $413,000 instead of $153,262.

The second alternative presented in this section involves the excavation of the on-site material with the subsequent shipment of this material to a RCRA hazardous waste landfill. Another source to use in the selection of a commercial landfill is the list of hazardous waste landfills that can receive material contaminated with PCB's. Two of these landfills are located relatively close to the A. L. Taylor site; the Waste Management facility in Emelle, Alabama and the CECOS facility in Williamsburg, Ohio.

A summary of the costs associated with the excavation and off-site disposal, in each of the above sites, of material from the A. L. Taylor site is presented in Table D-3. The estimating worksheets that correspond to these costs are included after the estimating worksheets for the RCRA landfill.

TABLE D-3. SUMMARY OF SOIL EXCAVATION AND DISPOSAL OPTIONS IN A RCRA LANDFILL

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The excavation of 31,700 yd^3 of material from the A. L. Taylor site with the transport of this material to CECOS International, Williamsburg, Ohio and disposal of this material at the site.	$4,359,425
Soil Removal Option #2:	
The excavation of 31,700 yd^3 of material from the A. L. Taylor site with the transport of this material to Waste Management, Inc., Emelle, Alabama and disposal of this material at the site.	$5,497,285

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There are no long term monitoring costs associated with this alternative.

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO.: 9349

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO / NO.: Excavation & Storage of Site Soils

ESTIMATE NO.:

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$300,000
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 45,000
				Engineering			5%						$ 15,000
				Contingency			15%						$ 45,000
				Indirects			5%						$ 15,000
				TOTAL									$420,000

ALT 001 001277

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | REV | INDEX NO

BUILDING NO / NOS: Excavation & Storage Site Soils

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Excavation of					31,700	yd^3	7.50		$237,750
				Contaminated Soils									
				Temporary Storage of					31,700	yd^3	0.70		$ 22,190
				Contaminated Soils;									
				Placed on Liner and									
				Covered									
				Placement of Contami-					31,700	yd^3	1.25		$ 39,625
				nated Soils in Landfill									
				SUBTOTAL									≈ $300,000

ALT 001 001273

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 3

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site - RCRA Landfill

TYPE OF ESTIMATE: PREL.

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO./NOS: Bottom Liner & Leachate Control

ESTIMATE NO.

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 3 of 3									$167,200
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 25,080
				Engineering			5%						$ 8,360
				Contingency			15%						$ 25,080
				Indirects			5%						$ 8,360
				TOTAL									$234,080

ALT 001 001279

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 3

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site-RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO / NOS: Bottom Liner & Leachare Control

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				6 inch thick clay					12,000	yd^2	1.85		$22,200
				foundation for support									
				of bottom liner. (It									
				may be necessary to									
				install piping to									
				collect water that									
				seeps between clay &									
				synthetic liner)									
				Chlorinated PE membrane					12,000	yd^2	4.75		$57,000
				(30 mil)									
				8 inches of drain rock					12,000	yd^2	7.00		$84,000
				Riser pipe, 8 inch					5	each	800		$ 4,000
				NC, installed									

ALT 001

001280

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 3 OF 3

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | RCV | INDEX NO

BUILDING NO / NOT: Bottom Liner & Leachate Control

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUBTOTAL									$167,200

ALT 001 001281

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO./NOS: Monitoring Well System (Groundwater)

ESTIMATE NO.

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$18,000
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 2,700
				Engineering			5%						$ 900
				Contingency			15%						$ 2,700
				Indirects			5%						$ 900
				TOTAL									$25,200

ALT 001 001282

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO 'NOS: Monitoring Well System (Groundwater)

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Groundwater Monitoring					3		3,500		$10,500
				Wells-30' deep, 4" ID,									
				Stainless Steel (1 up-									
				gradient, 2 downgradient)									
				Groundwater Monitoring					3		2,500		$7,500
				Wells-100' deep, 1.5"									
				ID,PVC (1 upgradient,									
				2 downgradient)									
				SUBTOTAL									$18,000

ALT 001 001283

ALT 001 | 001284

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 3

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | REV | INDEX NO

BUILDING NO / NOE: Surface Seal & Cover

ESTIMATE NO.

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 3									$322,625
				Sh. 3 of 3									$ 87,000
												SUBTOTAL	$409,625
				Site Services, Manpower, Health & Safety Equip. Etc.			15%						$ 61,450
				Engineering			5%						$ 20,500
				Contingency			15%						$ 61,450
				Indirects			5%						$ 20,500
				TOTAL									$573,525

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 3

PROJECT NO: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO / NOT: Surface Seal & Cover

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Topsoil, 12 inches					14,500	yd^2	5.55		$ 80,475
				Geotextile, jute mesh					14,500	yd^2	0.90		$ 13,050
				6 inches of drain rock					14,500	yd^2	5.50		$ 79,750
				40 mil, high density polyethylene liner					14,500	yd^2	4.75		$ 68,875
				18 inches of clay-like soil					14,500	yd^2	5.55		$ 80,475
				SUBTOTAL									$322,625

ALT 001 | 001280

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 3 OF 3

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | RCV | INDEX NO

BUILDING NO / NOT: Surface Seal & Cover

ESTIMATE NO.:

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				6 inch gravel gas					14,500	yd^2	6.00		$87,000
				collection layer with									
				NC riser pipes									
				SUBTOTAL									$87,000

ALT 001

001286

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 1 OF 2

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | REV | INDEX NO

BUILDING NO./NOV: Revegetation

ESTIMATE NO.

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$17,200
				Engineering			5%						$ 860
				Contingency			15%						$ 2,580
				Indirects			5%						$ 860
				TOTAL									$21,500

ALT 001 001287

ALT 001

00128

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ESTIMATE WORKSHEET

DATE: August 3, 1984

SHEET NO: 2 OF 2

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor - RCRA Landfill

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO / NOS: Revegetation

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Fertilizer; 0-20-20					4.5	A*	405		$1,800
				applied at 450 lbs. per									
				acre and 38-0-0, urea									
				form, applied at 250									
				lb.per acre.									
				Application of seed					4.5	A	720		$3,240
				mixture									
				Mulching of seeded					4.5	A	2700		$12,150
				areas									
				SUBTOTAL									$17,200

ALT 001

001229

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ESTIMATE WORKSHEET

DATE: August 7, 1984

SHEET NO: 1 OF 2

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | MODIFY NO

BUILDING NO / NOS: Soil Removal Option 1

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				SH. 2 of 2									$3,972,745
				The following items									
				apply to excavation and									
				transportation costs:				$966,850					
				site services Manpower, Health & Safety, Equip. Etc.			15%						$ 145,000
				Engineering			5%						$ 48,340
				Contingency			15%						$ 145,000
				Indirects			5%						$ 48,340
				TOTAL									$4,359,425

ALT 001

001250

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ESTIMATE WORKSHEET

DATE: August 7, 1984

SHEET NO: 2 OF 2

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | ALT | INDEX NO

BUILDING NO / NOV: Soil Removal Option 1

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Excavation of Soil					31,700	yd^3	7.50		$ 237,750
				Backfilling & Topsoil					32,000	yd^3	6.00		$ 192,000
				Transport to CECOS,Inc.					1,585	TL*	460		$ 729,100
				Williamsburg,OH: 31,700									
				yd^3/20 yd^3/TL									
				CERCLA Disposal Fee					31,500	T**	2.13		$ 67,095
				Disposal-CECOS-Ohio					31,500	T**	80		$2,520,000
				Ohio disposal tax								9% Disposal Tax	$ 226,800
												SUBTOTAL	$3,972,745
				*TL = Truck Load **T = Ton									

ALT 001

001291

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ESTIMATE WORKSHEET

DATE: August 7, 1984

SHEET NO. 1 OF 2

PROJECT NO.	LOCATION	PROJECT NAME
9849	Brooks, Kentucky	A.L. Taylor Site

TYPE OF ESTIMATE	ESTIMATOR	NEW	ALT	INDEX NO	BUILDING NO / NOR	ESTIMATE NO
PREL	Gregory P. Beronja				Soil Removal Option 2	

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				SUMMARY									
				Sh. 2 of 2									$4,463,095
				The following items									
				apply to excavation									
				and transportation									
				costs:				$2,298,250					
				Site Services, Manpower, Health & Safety, Equip., Etc.			15%						$ 344,740
				Engineering			5%						$ 114,910
				Contingency			15%						$ 344,740
				Indirects			5%						$ 114,910
				TOTAL									$5,382,395

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ESTIMATE WORKSHEET

DATE: August 7, 1984

SHEET NO: 2 OF 2

PROJECT NO.: 9849

LOCATION: Brooks, Kentucky

PROJECT NAME: A.L. Taylor Site

TYPE OF ESTIMATE: PREL

ESTIMATOR: Gregory P. Beronja

NEW | REV | INDEX NO

BUILDING NO/TNOS: Soil Removal Option 2

ESTIMATE NO

CODE A	CODE B	CODE C	CODE D	SYSTEM/SUBSYSTEM	LABOR QUANTITY	LABOR UNIT	LABOR $/UNIT	LABOR TOTAL	MATERIALS QUANTITY	MATERIALS UNIT	MATERIALS $/UNIT	MATERIALS TOTAL	TOTAL COST
				Excavation of Soil					31,700	yd^3	7.50		$237,750
				Backfilling & Topsoil					32,000	yd^3	6.00		$192,000
				Transport to Waste					1,585	TL	1,300		$2,060,500
				Management of Alabama,									
				31,700 yd^3/20 yd^3/TL									
				CERCLA Disposal Fee					31,500	T	2.13		$ 67,095
				Disposal-Waste Management					31,500	T	55		$1,732,500
				of Alabama, Emelle, AL									
				Indirects-Permits, Taxes								10% of dis-	$173,250
												posal cost	
												SUBTOTAL	$4,463,095

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APPENDIX E

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APPENDIX E

COMMENTS ON THE KENTUCKY GEOLOGIC SURVEY'S REVIEW OF A REPORT PREPARED BY GEOSCIENCE RESEARCH ASSOCIATES

This appendix covers Metcalf & Eddy's review of the Kentucky Geologic Survey's (KGS) attached letter dated June 15, 1984. The KGS letter contains their comments regarding the Geosciences Research Associates, Inc. (GRA) report on the hydrology at the A. L. Taylor site (Hydrologic Investigation, A. L. Taylor Site, Bullitt County, Kentucky, May 9, 1984) have been reviewed. The KGS critique of the report is presented as two general comments with discussion, followed by seven specific comments concerning the report conclusions. The KGS comments largely address issues that were discussed in this addendum.

The first general comment is that the estimated groundwater flow velocities are too low. The KGS points out that the groundwater flow rate computed by GRA was incorrect due to the omission of porosity in the calculation. The Metcalf & Eddy calculations (Appendix A of this document) include a porosity factor in calculating the aquifer flow velocity (travel rate). The inclusion of a porosity factor in the computation increases the calculated velocity. The KGS further states that GRA used the lowest hydraulic conductivity value obtained during testing at the site to calculate the groundwater flow velocity. Metcalf & Eddy used a conservative hydraulic conductivity (1.4×10^{-5} cm/sec) in calculating the aquifer flow velocity, resulting in a value that is over 40 times larger than the GRA calculation. The

KGS concludes that the flow rate could be as high as 10 ft/yr, based on a porosity of 10 percent. This compares reasonably well with the value of 2.41 ft/yr calculated by Metcalf & Eddy, based on a porosity of 30 percent (7.2 ft/yr at a porosity of 10%).

The second KGS general comment concerns the water quality testing program and the selection of the depth intervals that were screened in the monitoring wells. Metcalf & Eddy agrees with the KGS that groundwater sampling for "target" compounds may be inconclusive. Metcalf & Eddy discussed the GRA sampling program earlier in the addendum. The KGS also states that the monitoring wells may not have been screened in the proper intervals to detect possible contaminants. The monitoring wells were screened at varying intervals (wells 1, 2 & 5 were screened in weathered shale, well 3 was screened in the lower silty clay & upper weathered shale, and well 4 was screened in the lower alluvial/colluvial materials). The water quality data therefore represent different geologic zones and may not be indicative of the full extent of contamination in each zone.

The KGS memo concludes with seven comments regarding the conclusions in the GRA report.

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KGS Comment No.	M&E Comment
1.	M&E agrees that hydraulic conductivities ranging from 10^{-5} to 10^{-6} cm/sec are in the normal range for silt, silty sand, or sandstone. Whether or not these values should be considered "very low" (as described by GRA) is a matter of opinion.
2.	The groundwater flow direction appears to be in the direction of Wilson's Creek. However, as discussed on pg. 2-23 of this document, no water level contour map has been prepared for the A. L. Taylor Site, and therefore groundwater flow directions and gradients are largely assumed.
3.	Flow rates were discussed above in response to the first KGS general comment.
4.	Metcalf & Eddy's calculations show significant groundwater flow rates in the alluvium/colluvium and the weathered shale.
5&6.	Based on Metcalf & Eddy's review of previous reports, it appears that the groundwater both on-site and off-site is contaminated.
7.	The discussion of the final cover (clay cap) is summarized on pg. 3-12 of this document.

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APPENDIX F

APPENDIX F

SUMMARY OF PROPOSED REMEDIAL ALTERNATIVE COSTS

This section summarizes, in Table F-1, the costs of the remedial alternatives proposed by Ecology and Environment, Inc. (E&E) in their September 23, 1982 report, the PRP consultants in their September 1983 report, and Metcalf & Eddy in this report.

Table F-1 presents the capital costs, present worth, operation and maintenance (O&M) costs with no cost escalation consideration, present worth O&M costs with the cost escalation factor equal to that of the interest rate, and the total cost.

The costs presented for the E&E remedial alternatives are average costs of their upper and lower cost estimates.

TABLE F-1. SUMMARY OF PROPOSED REMEDIAL ALTERNATIVE COSTS

Alternative	Capital Cost	O&M Costs	O&M Costs[1]	Total Costs[2]
E&E Minimum Action Alternative	$157,000	$114,676	$332,200	$489,200
E&E Onsite Containment Alternative	$602,000	$239,290	$704,000	$1,306,000
E&E Excavate-and Relocate Alternative	$2,934,000	$86,396	$242,200	$3,176,200
PRP Consultant Onsite Containment Alternative	$531,875	$114,676	$332,200	$864,075
RCRA Landfill Alternative	$1,423,100	$294,656	$890,300	$2,313,400
RCRA Offsite Disposal Alternative #1	$4,359,425	-	-	$4,359,425
RCRA Offsite Disposal Alternative #2	$5,497,285	-	-	$5,497,285

1. These costs assume that the cost escalation factor is the same as the interest rate, 10%.
2. The total cost includes the O&M costs with the cost escalation factor the same as the interest rate.

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Reference 16

KENTUCKY GEOLOGICAL SURVEY
UNIVERSITY OF KENTUCKY, LEXINGTON
SERIES X, 1978
Wallace W. Hagan, Director and State Geologist

TOPOGRAPHY OF KENTUCKY

Preston McGrain and James C. Currens

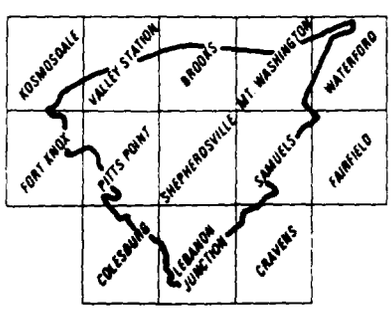
SPECIAL PUBLICATION 25

200 to 250 feet above the plain. The plateau, which is generally higher in the east than in the west, is moderately to deeply dissected. Large flat-topped ridges are present in several parts of the county. These flat areas, developed on resistant rock formations, give these regions a tableland appearance. Locally isolated hills or ridges rise 80 to 100 feet above the plateau surface. Rough River, Clover and Sinking Creeks, and other smaller streams are entrenched 100 to 150 feet below the upland. Entrenchment is greater near the Ohio River.

The highest elevation is approximately 920 feet, and is in the High Plains area of the extreme eastern part of the county on the drainage divide between tributaries of the Ohio River and Rough River. The greatest local relief is in the vicinity of the Ohio River. In the northeastern corner of the county, the difference in elevation from one hilltop to the Ohio River flood plain is 500 feet in a distance of about 3/4 mile. Locally, precipitous cliffs are present along some of the streams.

The elevation of Hardinsburg, the county seat, is 714 feet. Elevations of other communities are Cloverport, 411 feet; Custer, 824 feet; Glen Dean, 466 feet; Harned, 755 feet; Irvington, 620 feet; Lodiburg, 520 feet; Madrid, 773 feet; McDaniels, 670 feet; and Stephensport, 423 feet. The elevation of Rough River Lake at normal pool level is 495 feet.

BULLITT COUNTY



Bullitt County, located in northern Kentucky immediately south of the Louisville area, has a diverse topography. The extreme eastern tip of the county is in the rolling hills of the Outer Blue Grass region. The western part of the county is in the area of rugged topography of the Knobs and dissected upland behind Muldraugh Hill (Highland Rim escarpment). Between these eastern and western portions of the county is a region containing some broad flat areas—an upland plain developed on resistant rocks and wide alluviated valleys carved from soft rocks.

Elevations generally decrease from about 700 feet in the eastern part of the county to 500 feet at the edge of the Knobs region and upland escarpment. The lowest elevations in the county are in the valleys of Rolling Fork and Salt River, which form the western boundary of Bullitt County. The elevation of Salt River where it leaves the northwestern corner of the county is about 385 feet. Broad, alluviated flats adjacent to the lower reaches of Salt River are approximately 450 feet in elevation.

Muldraugh Hill, an eastward-facing cuesta, and the isolated round hills or knobs carved from this upland are the most conspicuous topographic features of Bullitt County and contain both the highest elevations and the sites of greatest local relief. Slopes are steep but cliffs are rare. Individual knobs may rise 400 feet or more above the valleys of Rolling Fork and Salt River. The highest elevation in the county is 998 feet, the top of a knob some 3 1/2 miles northeast of Lebanon Junction. Elevations of some other knobs are Buttonmold Knob, 804 feet; Dawson Knob, 980 feet; Phelps Knob, 789 feet; and the knob on which the lookout tower in Bernheim Forest is located, 921 feet. Precise elevations have been determined for many more peaks, and this information can be obtained from individual topographic maps.

The hills and ridges at the eastern edge of Muldraugh Hill may attain elevations in excess of 900 feet. Two points adjacent to Brooks Hill have elevations of 912 and 917 feet, some 400 feet above the lowland immediately to the east. This upland area decreases in elevation toward the western border of the county where ridgetops are generally 700 to 750 feet in elevation, approximately 300 feet above the flood plain of the Ohio River.

The elevation of Shepherdsville, at the courthouse, is 449 feet. Other elevations of interest include Belmont, 456 feet; Brooks, 515 feet; Clermont, 478 feet; Lebanon Junction, 454 feet; Mount Washington, 688 feet; and the entrance to Bernheim Forest, approximately 500 feet.

BUTLER COUNTY

Butler County is located near the southeastern edge of the Western Kentucky coal field. The meandering valley of Green River is the most conspicuous topographic feature in the county. Green River marks portions of the southern and northwestern boundaries and bisects the county in a northwesterly direction. Great Bend, a large meander loop almost 9 miles long and 2 to 3 miles

Reference 17

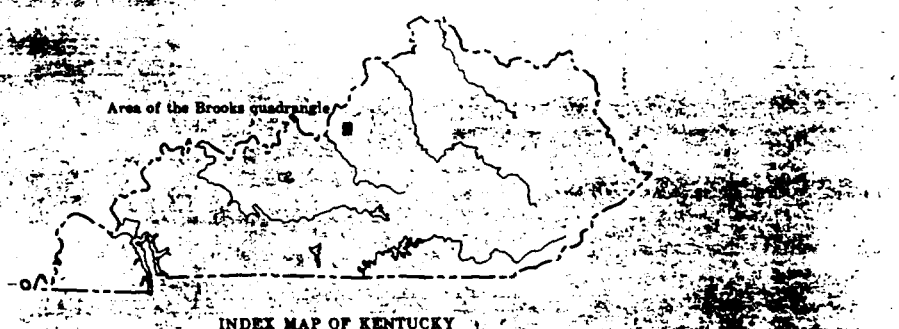
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY
UNIVERSITY OF KENTUCKY
KENTUCKY GEOLOGICAL SURVEY
WALLACE W. HAGAN, DIRECTOR AND
STATE GEOLOGIST

GEOLOGIC QUADRANGLE MAPS OF THE UNITED STATES

GEOLOGIC MAP OF THE BROOKS QUADRANGLE BULLITT AND JEFFERSON COUNTIES KENTUCKY

By
Roy C. Kepferle



INDEX MAP OF KENTUCKY

PUBLISHED BY THE U.S. GEOLOGICAL SURVEY
WASHINGTON, D.C. 20242
1972

KEPFERLE—BROOKS, KY.

PREPARED IN COOPERATION WI
THE COMMONWEALTH OF KENTUCKY, UNIVEF
KENTUCKY GEOLOGICAL SUF
WALLACE W. HAGAN, DIRECTOR AND STAT

GEOLOGIC QUADRANGLE MAP
BROOKS QUADRANGLE, KENTUCKY
GQ-961

E X P L A N A T I O N

QUATERNARY

Holocene

Qal

*Alluvium

Pleistocene

Wisconsin

Qla

*Lacustrine deposits

Illinoian(?) and Wisconsin

Ql

*Loess

Illinoian(?)

Qt

*Terrace deposits

*Adapted in part from soil map of Jefferson County (Zimmerman, 1966)

MISSISSIPPIAN

Ms

Salem Limestone

Harrodsburg Limestone

Mbm
st
Mbn
Mbnp
Mbk

Borden Formation

Mbm, *Muldraugh Member*
†Mbh, *Holtsclaw Siltstone Member*
Mbn, *Nancy Member*
st, *siltstone beds*
‡Mbk, *Kenwood Siltstone Member*
Mbnp, *New Providence Shale Member*

IAN

Contact

Dotted where concealed; not shown where extensively concealed by mapped surficial deposits. See unit descriptions for discussion. Triangles indicate selected localities where contact was well exposed at time of mapping

Strike of vertical joint

Strikes of vertical joint sets

Bearing of sole mark lineation in siltstone bed

Structure contours

Drawn on top of New Albany Shale in west, top of Laurel Dolomite in east. Projected where contoured horizon is missing. Contour interval 20 feet

DRILL HOLES FROM WHICH SUBSURFACE DATA WERE OBTAINED

USGS auger hole

Water well

Quarry

Abandoned quarry

Clay pit

Abandoned clay pit

7656-SD

Outcrop of fossil-bearing strata

Middle Upper D

New Albany Shale and Beechwood Limestone Member of Sellersburg Limestone — DEVO

UNCONFORMITY

Slv

Louisville Limestone

Waldron Shale

Middle Silurian

Sl

Laurel Dolomite

So

Osgood Formation

Lower Silurian

Brassfield Formation — SILURIAN

UNCONFORMITY(?)

Upper Ordovician

Ods

Saluda Dolomite Member of Drakes Formation — ORDOVICIAN

af

Artificial fill

*The Holtsclaw Sandstone (Butts, 1915) is here redefined as the Holtsclaw Siltstone Member of the Borden Formation. The type locality is at Holsclaw Hill, located near the west boundary of the quadrangle

‡The Kenwood Sandstone (Butts, 1915) is here redefined as the Kenwood Siltstone Member of the Borden Formation

ECONOMIC GEOLOGY

Crushed limestone and dolomite for agriculture, aggregate, and fill are obtained from the Louisville Limestone and Laurel Dolomite. Three quarries were operating in the Louisville Limestone at the time of mapping. The now abandoned quarry just east of the Kentucky Turnpike south of Hebron Lane furnished much of the base course and aggregate for the Turnpike that lies in the quadrangle. Additional fill material for the Turnpike was obtained from two large borrow pits in the weathered New Albany Shale.

Clay from the New Providence Shale Member of the Borden Formation is used for making brick and tile at the Coral Ridge pit of the General Shale Products Company at the southwest end of South Park Hills, and is converted to light-weight aggregate at the Hubers Kenlite Station pit of the Ohio River Sand Company in the central part of the quadrangle. Clay from the lacustrine deposits of the Salt River-Rolling Fork ponding in the southern part of the quadrangle may be suitable for brick and tile according to analyses of samples from the Lebanon Junction quadrangle to the south (Peterson, 1967). This clay, as well as clay shale from the New Providence Shale Member, becomes plastic when wet, and roads on this material, where inadequately drained, tend to yield and push out under heavy traffic, or to slump or flow on oversteepened cuts.

Dimension stone has been quarried from local small pits in the Kenwood Siltstone Member of the Borden.

At least seven test wells have been drilled in the quadrangle in unsuccessful attempts to discover commercial amounts of oil and gas.

Water for domestic and farm use is readily obtained from wells in the carbonate units east of the Turnpike. Springs issue from their base directly above the Osgood Formation and Waldron Shale. Non-saline ground water is difficult to obtain from the area underlain by the Borden in the western part of the area, except from local shallow wells in the Muldraugh Member or the Harrodsburg Limestone. Some water is available from gravel lenses near the base of the lacustrine deposits. (See also Palmquist and Hall, 1960.)

The quadrangle is in an area of rapid suburban residential development owing to its proximity to Louisville. Because of the lack of permeability in the Borden Formation, New Albany Shale, and lacustrine deposits, and because of solution cavities in the carbonate units to the east, most of the mapped area is unsuited for septic tank or cesspool methods of sewage disposal. Provision should be made for adequate sewage disposal plants for all areas of suburban development.

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———1971, Geologic map of the Valley Station quadrangle and part of the Kosmosdale quadrangle, north-central Kentucky: U.S. Geol. Survey Geol. Quad. Map GQ-962. (In press).

Palmquist, W. N., Jr., and Hall, E. R., 1960, [illegible]

Reference 18

Summary of Geologic Conditions of the Louisville Area, Kentucky

GEOLOGICAL [illegible]

Prepared in [illegible] Commonwealth of [illegible] University of Kentucky Kentucky Geological Survey

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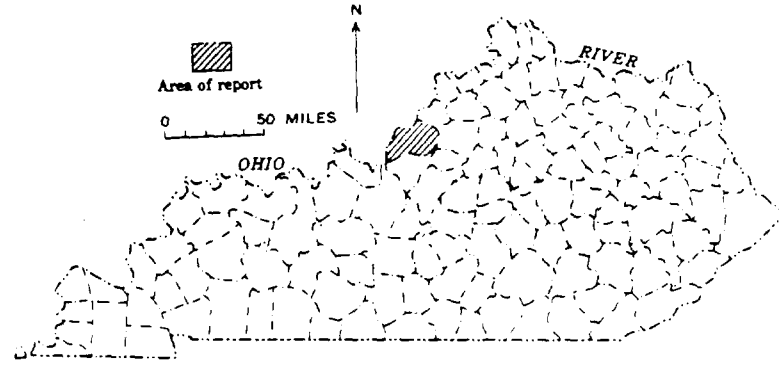

FIGURE 1.—Area covered by this report.

nishes water suitable for all local uses, provides a navigation avenue for 80 million tons of freight annually (1959–61), and provides recreational areas. The average discharge of the river at Louisville is so large—113,900 cfs (cubic feet per second), or more than 73 billion gallons per day—that a water shortage seems inconceivable. Despite the abundance of water, its chemical and biological quality is affected by contamination from untreated domestic sewage and industrial wastes discharged into the river upstream from Louisville.

The smaller streams in the Louisville area, which all flow directly or indirectly into the Ohio River, are relatively unimportant as sources of water because their flows in dry years become very low or cease entirely.

The part of local precipitation that does not become surface runoff or is not evaporated enters the ground and replenishes soil moisture or seeps further downward to the zone of saturation and recharges the ground-water reservoirs. Ground water in the area is discharged through wells and springs or moves generally westward and northwestward where it seeps into the river or leaves the area as subsurface underflow. Figure 2 is a generalized diagram showing the occurrence and direction of movement of waters in the Louisville area.

GEOLOGIC FRAMEWORK

The geologic framework that controls the availability of water in the Louisville area is illustrated by the block diagram (pl. 1). The upland areas are underlain by shale and limestone of Silurian, Devonian, and Mississippian ages. These rocks dip to the southwest at about 40 feet per mile. The present valley of the Ohio River along the western and northwestern part of the area was cut into the shale and

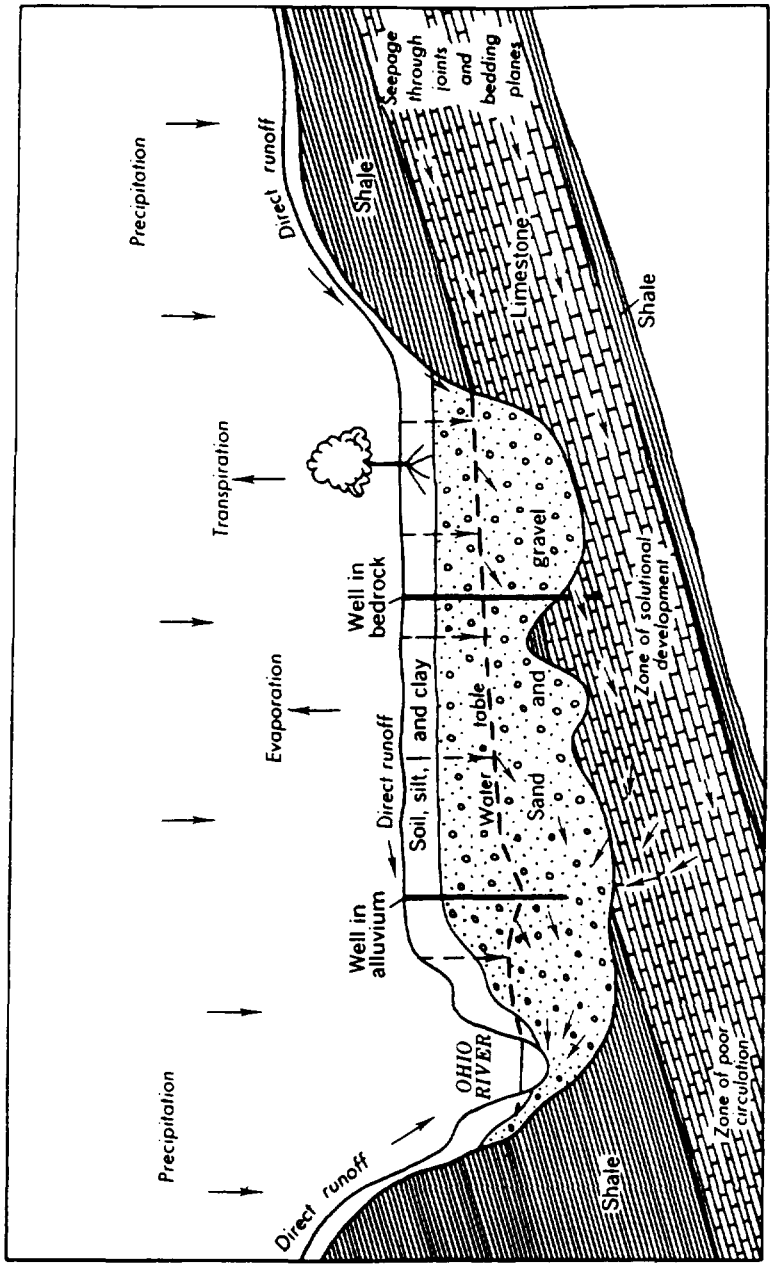

FIGURE 2.—Hydrologic cycle in the Louisville area, Kentucky.

limestone during glacial times. The rock valley is filled with alluvium of Quarternary age which underlies the Ohio River flood plain to a maximum depth of 130 feet. (In this report, the Ohio River flood plain is defined as the entire surface area of the alluvium filling the rock valley.) The alluvium consists of glacial outwash, sand, and gravel and a blanket of Recent silt and clay, and is connected hydraulically with the Ohio River along much of its course in the area.

The glacial deposit of sand and gravel in the flood plain has a vast water-storage capacity and high transmissibility and is the principal aquifer in the Louisville area. The limestone provides a secondary aquifer, particularly where solution openings occur along extensive joint systems and well-formed bedding planes. Limestone in the central part of Jefferson County yields water to many domestic wells, and the limestone bedrock beneath the glacial sand and gravel in the city yields large quantities of water to industrial wells.

The clay and shale are not significant as aquifers but are important because they influence the flow of water to and from other formations.

Formations of Ordovician and Silurian ages are exposed in the eastern third of the county. Formations of Mississippian age comprise the bedrock of the Knobs area in the southwestern part of the county. These formations, however, are not of hydrologic importance locally and are not defined in the local hydrologic system.

HYDROLOGY

The Louisville area is at times affected by cold airmasses from the northwest and Great Lakes area, by the warmer air sweeping up the Mississippi and Ohio Valleys from the Gulf region, and by the meeting of these two opposing airmasses. The resulting variation in precipitation affects the local hydrologic system.

The normal annual precipitation at Standiford Airport (U.S. Weather Bur. records) for the period 1931–60 is 41.32 inches. (See fig. 3.) If it is assumed that this amount is the average throughout the Louisville area and that losses to evaporation and transpiration are about 60 percent of the precipitation, an average of nearly one-third of a billion gallons is added daily to the amount of water that moves through the area, either on or in the ground. This is less than one-half of 1 percent of the average amount of water that the Ohio River brings in from outside the area each day.

In the eastern third of Jefferson County and in the Knobs area south of Louisville, topographic highs and lows are pronounced, and much of the precipitation leaves the area rapidly as overland runoff to local streams. Only a small amount of water seeps below the soil mantle

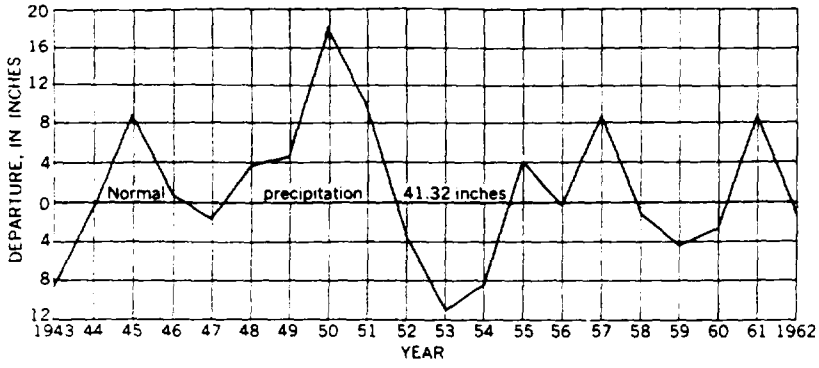

FIGURE 3.—Departure from normal precipitation at U.S. Weather Bureau station, Louisville, Ky., 1943–62. Normal precipitation determined by U.S. Weather Bureau, based on period 1931–60.

to the underlying limestone. In the central part of the county, and extending to the Ohio River valley, the relief is relatively flat, the runoff is generally slower, and recharge to ground-water storage in the underlying limestone is substantially higher. Ground-water flow is generally toward the Ohio River valley except in the extreme eastern part of the county where the flow is toward the south.

In the flood plain the many buildings and great amount of pavement limit the area in which water can enter the ground; also, the low permeability of a silt-and-clay blanket impedes downward seepage of water into the more permeable sand and gravel. Consequently, direct recharge of the alluvial aquifer by precipitation is decreased. Infiltration from the Ohio River in the northeastern part of Louisville and flow through the rock valley wall are major contributors of water to the sand and gravel. The deposit of sand and gravel with its vast storage of water, estimated to be nearly 100 billion gallons (Bell, 1962), supplies many industrial wells in the area and is the source of water for the Louisville Extension Water District in the southwestern part of the county.

Water in the area is predominantly of calcium magnesium bicarbonate type and contains appreciable concentrations of sulfate. Ground water is generally harder than surface water and contains more dissolved solids.

RELATION OF HYDROLOGIC SYSTEM TO WATER UTILIZATION

The Louisville area has an abundant water supply: Its optimum use is controlled primarily by the (1) variation of precipitation (seasonal and local), (2) hydrologic character of soil and rock, and (3) dynamics of fluid flow.

Reference 19

SOIL SURVEY

Jefferson County Kentucky

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
KENTUCKY AGRICULTURAL EXPERIMENT STATION

clay below a depth of about 16 inches. It is exposed in some places. There are a few shallow gullies.

The plow layer is low in organic-matter content and thus is generally difficult to till. The natural fertility is moderate, and the response to fertilizer is fair. Liming is beneficial, except where the neutral subsoil is exposed. The moisture-supplying capacity is moderate, and crop yields may be reduced because of insufficient moisture. Permeability is slow in the subsoil. The depth of the root zone is limited to about 16 inches by the calcareous subsoil.

Because the erosion hazard is severe, this soil is not well suited to cultivated crops. It is best suited to pasture and wood crops. Kentucky 31 fescue and sericea lespedeza grow well. (Capability unit VIe-2; woodland suitability group 11; wildlife productivity group 3)

Breaks and Alluvial Land

This is a miscellaneous land type that consists of areas of unconsolidated alluvium. These areas are along the Ohio River. Most are strongly sloping or steep, and a few are nearly level. Some include an escarpment. The alluvium washed from the upper part of the Ohio River drainage basin. In places the deposits of alluvium are recent and are subject to yearly change, but in other places they have remained long enough to be distinguishable as weakly developed terrace soils. The soil material is mostly medium textured, but it is coarse textured in places and fine textured in others.

This land type is subject to flooding and consequently is not suitable for cultivation or for pasture. During the spring flood season, rapid river currents often severely scour the areas or leave new deposits of alluvium. Overflows of short duration are likely to occur at any time during the normal cropping season.

Breaks and Alluvial land (Br).—This miscellaneous land type is not suitable for agricultural use. Occasionally a small strip is planted to corn, but the crop is generally damaged or lost. (Capability unit VIIe-4; woodland suitability group 16; wildlife productivity group 3)

Captina Series

The Captina series consists of moderately well drained, level to gently sloping soils on low terraces along Floyds Fork and along large creeks in the limestone area. The acreage is moderate. These soils formed in old alluvium that washed from soils of limestone origin. They have a compact, brittle fragipan at a depth that ranges from 18 to 26 inches. Representative profile:

0 to 10 inches, dark-brown, friable silt loam.
10 to 21 inches, dark yellowish-brown, friable silty clay loam; blocky structure.
21 to 38 inches, mottled yellowish-brown and gray, firm silty clay loam; compact and brittle (fragipan).
38 to 48 inches, yellowish-brown and gray, firm silty clay; massive.

Captina soils are strongly acid. They are moderate in natural fertility but respond well to fertilizer. The depth of their root zone is limited by the fragipan.

These soils, for the most part, have been cleared and are presently cultivated or in pasture. They are suited to most crops that do not require good drainage and a deep root zone. Most areas are above the normal flood plain and, therefore, are only occasionally flooded.

Captina silt loam, 0 to 2 percent slopes (CaA).—This is a moderately well drained, alluvial soil that has a fragipan. Normally the plow layer consist of dark-brown, friable silt loam and is about 9 or 10 inches thick. The upper part of the subsoil is dark yellowish-brown silty clay loam, and the lower part, or fragipan, is mottled yellowish-brown and gray, firm, compact, brittle silty clay loam. The fragipan, which begins at a depth of about 21 inches, restricts the movement of water and limits the depth of the root zone.

The plow layer is medium in organic-matter content and is easy to till. It is moderate in natural fertility but benefits from fertilizer. It is strongly acid but responds well to lime. Surface runoff is slow, consequently some areas remain wet after a rainy period. Permeability is moderate in the upper part of the subsoil and very slow in the lower part. The moisture-supplying capacity is limited because of the fragipan.

This soil is well suited to Kentucky 31 fescue, redtop, alsike clover, red clover, Kobe lespedeza, and Korean lespedeza. It is not well suited to alfalfa and other deep-rooted crops. Corn and soybeans can be grown, but yields are moderate and high-level management must be used. Erosion is not a limitation, so intensive cultivation is not harmful. Crops in the lower lying areas may be damaged by occasional floods. Crop yields may be reduced during a dry period. (Capability unit IIw-1; woodland suitability group 5; wildlife productivity group 2)

Captina silt loam, 2 to 6 percent slopes (CaB).—This is a moderately well drained, alluvial soil that has a fragipan. Normally the plow layer consists of dark-brown, friable silt loam and is about 8 inches thick. The upper part of the subsoil is dark yellowish-brown, friable silty clay loam, and the lower part, which is the fragipan, is mottled yellowish-brown and gray, firm, compact silty clay loam. The fragipan, which begins at a depth of about 24 inches, limits the depth of the root zone and restricts the movement of water.

Mapped with this soil are a few spots of soils that have slopes stronger than 6 percent and a few areas of soils that are slightly eroded.

The plow layer is generally medium in organic-matter content and is easy to till. It is moderate in natural fertility but benefits from fertilizer. It is strongly acid, but it responds well to lime. The moisture-supplying capacity is limited because of the fragipan.

The erosion hazard is slight. Nevertheless, if cultivated, this soil needs specific conservation practices that will effectively control runoff and erosion. Crop yields may be reduced during a dry period. (Capability unit IIe-6; woodland suitability group 5; wildlife productivity group 2)

Captina silt loam, 6 to 12 percent slopes, eroded (CaC2).—This is a moderately well drained, alluvial soil that has a fragipan. Normally the plow layer consists of grayish-brown, friable silt loam and is about 6 inches thick. The subsoil is yellowish-brown silt loam in the upper part and grades to yellowish-brown, mottled gray and olive silty clay loam below a depth of 21 inches. This lower part of the subsoil is the fragipan; it is compact and brittle, and it limits the depth of the root zone and restricts the movement of water. In plowing, ma-

The natural fertility of this soil is moderate, and the reaction is medium acid. The root zone is deep, and the moisture-supplying capacity is high. Permeability is moderate in the subsoil.

This soil is subject to severe erosion and consequently is not suited to cultivated crops. It is well suited to pasture and has a high potential for wood crops. Under good management, all the local grasses and legumes grow well. The operation of machinery on this soil is restricted, and the control of weeds and brush is difficult. (Capability unit VIe–7; woodland suitability group 10; wildlife productivity group 2)

Muskingum Series

This series consists of shallow, somewhat excessively drained soils on moderately steep or steep slopes of the Knob Hills. These soils are of moderate extent. They formed principally in residuum derived from shale, siltstone, and some sandstone, but in some areas the upper layers formed in loess (windblown silt) that is as much as 20 inches thick. The deeper soils generally have a thicker mantle of loess. Representative profile:

0 to 3 inches, dark-gray, very friable silt loam.
3 to 6 inches, grayish-brown, very friable silt loam.
6 to 18 inches, yellowish-brown, friable silt loam; very strongly acid.
18 to 25 inches, light olive-brown to yellowish-brown silt loam; few variegations in lower part; abundant small fragments of shale and siltstone; very strongly acid.
25 inches +, siltstone and shale bedrock.

The shale and siltstone fragments on the surface and throughout the soil material vary in number from place to place. The depth to bedrock ranges from about 20 to 36 inches.

Muskingum soils are moderate in natural fertility, and they are very strongly acid. Because they are steep and shallow, they are best suited to woods and to pasture. Only a small part of their acreage, however, has been cleared for pasture.

Muskingum stony soils, 30 to 50 percent slopes (MuF).—These are somewhat excessively drained, shallow soils that formed in residuum derived from siltstone, sandstone, and shale. Very fine grained sandstone and siltstone, 10 to 36 inches in diameter, are common on the surface and throughout the soil material. Larger stones and outcrops are scattered throughout the area. Generally the surface layer and the subsoil consist of silt loam, but in a few areas the lower part of the subsoil ranges from silt loam to silty clay loam. Normally the surface layer is brown and the subsoil is yellowish brown. The depth to bedrock ranges from 20 to 36 inches.

These soils are moderate in natural fertility, and they are strongly acid. Their moisture-supplying capacity is low, and they are limited in use by droughtiness. The depth of the root zone is limited by loose stones in the soil material.

These soils are not suitable for cultivation and ordinarily are not suitable for pasture. Their potential for wood crops is only fair, but generally trees are the best use. The steep slopes preclude the use of machinery in most places. (Capability unit VIIs–2; woodland suitability groups 8 and 9; wildlife productivity group 3)

Newark Series

The Newark series consists of deep, somewhat poorly drained soils of the first bottoms. These soils are widely scattered throughout the creek and river valleys. Their acreage is moderate. Those soils along small creeks formed in sediment that washed mostly from soils of limestone origin, and those in the Ohio Valley formed in mixed sediment that washed from the upper part of the Ohio River basin. Representative profile:

0 to 9 inches, dark grayish-brown, friable silt loam.
9 to 17 inches, dark grayish-brown, friable silt loam; few olive-brown mottles; massive.
17 to 48 inches +, dark grayish-brown silt loam; many olive and gray mottles; massive.

In some areas the material below the surface layer is silty clay loam or loam; in places it is stratified.

Generally these soils are slightly acid. They have a high moisture-supplying capacity, a deep root zone, and other qualities that promote plant growth.

These soils, for the most part, are cultivated. If drained they can be cultivated continuously, and they are productive. Nearly all of the locally grown crops are suitable. The lower lying areas are subject to flooding, but floods are of short duration and usually occur before the normal crop season.

Newark silt loam (Ne).—This is a deep, somewhat poorly drained soil of the first bottoms. It formed in recent alluvium that is principally of limestone origin. The surface layer normally consists of dark grayish-brown, friable silt loam and is about 9 inches thick. The upper part of the subsoil is dark grayish-brown silt loam that has a few olive mottles. The lower part, which begins at a depth of about 17 inches, is mottled grayish-brown and olive silt loam.

Mapped with this soil is a small acreage of soils that have a surface layer of silty clay loam.

The plow layer of this soil is medium in organic-matter content and is easy to till. The natural fertility is moderately high, and generally fertilizer increases productivity. The reaction is slightly acid, but the response to lime is good. The moisture-supplying capacity is high, and plants seldom are damaged because of insufficient water.

This soil is suited to corn, soybeans, and other general crops. It is not subject to erosion and it can be cultivated continuously under high-level management. Occasionally, floods late in spring may delay plowing and planting, and in some years floods may damage growing crops in low-lying areas. Wetness can be reduced in most places by tile and surface drainage. (Capability unit IIw–4; woodland suitability group 3; wildlife productivity group 2)

Otway Series

This series consists of shallow, somewhat excessively drained, strongly sloping soils. These soils are not extensive but are widely scattered throughout the eastern third of the county. They formed in residuum derived from soft, calcareous shale (marl) and from some thinly interbedded limestone. Representative profile:

0 to 4 inches, very dark grayish-brown silty clay; slightly sticky.
4 to 10 inches, olive silty clay or clay; sticky and plastic; strong, blocky structure.

10 to 15 inches, olive-gray clay variegated with olive brown and olive; very plastic; massive; calcareous.
15 inches +, weathered, calcareous shale (marl).

These soils are low in natural fertility. They are mildly alkaline to strongly alkaline. The heavy, calcareous clay limits the depth of their root zone, and thus their moisture-supplying capacity is low. Plants do not receive sufficient moisture, especially during a dry period.

These soils are susceptible to severe erosion and consequently are not suitable for cultivation. They are suited to pasture and to woods, but their yield potential is low. About half of the acreage has been left wooded. The wooded areas, for the most part, have been cut over and contain low-quality trees. Some idle fields are going back to woods.

Otway silty clay, 12 to 20 percent slopes (OcD).—This is a shallow soil that formed in residuum derived from calcareous shale (marl). It is on strongly sloping hillsides in the eastern third of the county. Normally the surface layer consists of very dark grayish-brown silty clay and is about 4 inches thick. The subsoil is olive, plastic silty clay in the upper part and grades to calcareous clay at a depth of about 12 to 14 inches.

A few areas where slopes are stronger than 20 percent are mapped with this soil.

The root zone of this soil is shallow; its depth is limited by the heavy, calcareous clay. The moisture-supplying capacity is low, and plant growth is affected in a dry period. The natural fertility is moderately low, and the response to fertilizer is poor because of other limiting characteristics of the soil. This soil is mildly alkaline, or it is calcareous. It is medium in organic-matter content and is generally difficult to till. If plowed when too moist, it is likely to clod.

Erosion is a severe hazard on this soil, and consequently cultivation is not practical. The soil is suitable for pasture and woods, but its yield potential is low. (Capability unit VIe-1; woodland suitability group 11; wildlife productivity group 3)

Otway silty clay, 12 to 20 percent slopes, severely eroded (OcD3).—This is a shallow soil that formed in residuum derived from calcareous shale (marl). In most places the original surface layer has been removed, and the present plow layer consists of grayish-brown and olive, plastic clay. It is about 4 inches thick. The subsoil is olive-gray and gray, plastic, calcareous clay.

A small area where slopes are stronger than 20 percent is mapped with this soil.

The root zone of this soil is shallow; its depth is limited by the calcareous clay. The moisture-supplying capacity is low. The natural fertility also is low.

This soil, because of unfavorable characteristics, is not suitable for cultivation. Under high-level management it produces only limited pasture from Kentucky 31 fescue or from sericea lespedeza. Its potential for wood crops is low. Redcedar is the most suitable kind of tree for this soil. (Capability unit VIIs-3; woodland suitability group 11; wildlife productivity group 3)

Purdy Series

The Purdy series consists of level, poorly drained soils on low terraces along small creeks in the Knob Hills. The acreage is small. These soils formed in old alluvium that washed principally from soils of sandstone and shale origin. They have a brittle, compact fragipan at a depth of 14 to 26 inches. Representative profile:

0 to 8 inches, dark grayish-brown, friable silt loam; many gray mottles.
8 to 18 inches, pale-brown silty clay loam; many gray mottles.
18 to 36 inches, mottled gray, grayish-brown, and yellowish-brown silty clay loam; compact and brittle (fragipan).

These soils are medium acid or strongly acid. Their potential for most row crops is moderately low, so they are used mostly for pasture and hay. Some areas have been left wooded, mainly because the soils there are too wet for any other use. Most areas are flooded occasionally.

Purdy silt loam (Pd).—This is a level, poorly drained soil on low terraces along creeks. Normally the plow layer consists of dark grayish-brown, friable silt loam and is about 8 inches thick. The subsoil, to a depth of about 18 inches, is pale-brown silty clay loam that has many gray mottles. It grades to mottled gray, grayish-brown, and yellowish-brown silty clay loam that is compact and brittle. This lower part of the subsoil is a fragipan. It limits the depth of the root zone and restricts the movement of water.

The plow layer is low in organic-matter content but nevertheless is easy to till. The natural fertility is moderately low, and the response to fertilizer is only fair because of other unfavorable characteristics of the soil. The reaction is strongly acid, but lime helps to correct the acidity. The moisture-supplying capacity is moderately low, and plants are generally damaged in a dry period because of insufficient moisture.

This soil is not subject to erosion, so it can be cultivated continuously but under high-level management. It is best suited to soybeans, alsike clover, Korean lespedeza, and crops that tolerate some wetness. Wetness in spring and after heavy rains often delays plowing and cultivation. (Capability unit IVw-1; woodland suitability group 3; wildlife productivity group 3)

Robertsville Series

The Robertsville series consists of poorly drained alluvial soils on low terraces along Floyds Fork and along large creeks in the limestone area. The acreage is moderately large. These soils formed in old alluvium that washed from soils of limestone origin. They have a brittle, compact fragipan at a depth of 12 to 20 inches. Representative profile:

0 to 6 inches, grayish-brown, friable silt loam; few gray mottles.
6 to 15 inches, gray silt loam; many brown mottles; weak blocky structure.
15 to 38 inches, mottled gray and yellowish-brown silty clay loam; compact and brittle (fragipan).

The fragipan is weakly developed in some areas.

Generally these soils are very strongly acid. Their potential for most row crops is low, mainly because they are wet and have a fragipan. Thus, they are used mostly for hay and pasture crops that tolerate wetness. Some excessively wet areas have been left wooded.

Robertsville silt loam (Rb).—This is a nearly level, poorly drained, alluvial soil on low terraces along creeks. Normally the plow layer is grayish-brown, friable silt loam that has a few gray mottles. The subsoil, to a depth of

IIe-2; woodland suitability group 7; wildlife productivity group 1)

Woolper silty clay loam, 6 to 12 percent slopes, eroded (WmC2).—This is a deep, well drained or moderately well drained soil at the base of steep, limestone hillsides. Normally the plow layer consists of dark-brown silty clay loam and is about 6 inches thick. The subsoil is dark yellowish-brown silty clay loam in the upper part and grades to yellowish-brown or dark yellowish-brown silty clay at a depth of about 8 to 10 inches. The lowermost part of the subsoil, which begins at a depth of about 32 inches, is mottled yellowish-brown and gray. In plowing, material from the upper part of the subsoil has been mixed with the plow layer. Sheet erosion has removed nearly all of the original surface layer in some places, and patches of subsoil are exposed.

The plow layer is slightly difficult to till because of the clay content. Furthermore, it clods or crusts if plowed or cultivated when too dry or too wet. The natural fertility is high, and fertilizer helps to increase productivity. The reaction is slightly acid or neutral, and therefore little or no lime is needed. The moisture-supplying capacity is high, and plants usually receive sufficient water, except during an extended dry period. Permeability is slow in the subsoil.

This soil is suited to almost all the locally grown crops. If cultivated, it needs a suitable cropping system and specific conservation practices that will effectively control erosion, which is a moderate hazard. A few spots are wet because of seepage from the adjacent hillsides. (Capability unit IIIe-4; woodland suitability group 7; wildlife productivity group 1)

Zanesville Series

The Zanesville series consists of moderately well drained or well drained silty soils. These soils are confined to the Knob Hills in the southwestern part of the county. Generally they are in gently sloping to strongly sloping areas near the base of the hills. Their acreage is moderate. Their surface layer and the upper part of their subsoil formed mostly in loess (windblown silt) that is about 30 inches thick. The lower part of their subsoil formed in residuum derived from sandstone and shale. This lower part is a compact, brittle fragipan that limits the depth of the root zone and restricts the movement of water. Representative profile:

0 to 7 inches, brown, friable silt loam.
7 to 29 inches, strong-brown to brown silt loam; medium, blocky structure.
29 to 40 inches, yellowish-brown silty clay loam; grayish-brown and gray mottles; compact and brittle (fragipan).

The fragipan is 6 to 12 inches thick and is weakly developed in places. It is at a depth of 24 to 38 inches. Sandstone and shale bedrock is generally at a depth of more than 4 feet.

Zanesville soils are medium acid or strongly acid. Most areas are cultivated or are in pasture. Nearly all general crops can be grown, but yields are moderate.

Zanesville silt loam, 2 to 6 percent slopes (ZaB).—This is a well drained or moderately well drained soil of the Knob Hills. Normally the plow layer is brown, friable silt loam. The subsoil is strong-brown to brown silt loam to a depth of about 29 inches. It grades to mottled yellowish-brown and gray silty clay loam that is compact and brittle. This lower part of the subsoil is a fragipan that limits the depth of the root zone and restricts the movement of water. Sandstone and shale bedrock is at a depth of more than 4 feet.

The plow layer is medium in organic-matter content. It can be tilled throughout a wide range of moisture content without clodding or crusting. The natural fertility is moderate, but fertilizer helps to increase productivity. The reaction is medium acid or strongly acid, but the response to lime is good. The moisture-supplying capacity is high; only in an extremely dry period is plant growth affected because of insufficient moisture.

This soil is suited to corn, small grain, soybeans, tobacco, hay, and pasture, but not to alfalfa and other deep-rooted crops. If cultivated, it needs a suitable cropping system and specific conservation practices that will effectively control runoff and erosion. Erosion is a moderately low hazard. (Capability unit IIe-10; woodland suitability group 4; wildlife productivity group 2)

Zanesville silt loam, 6 to 12 percent slopes, eroded (ZaC2).—This is a well drained or moderately well drained soil of the Knob Hills. Normally the plow layer is brown, friable silt loam. The subsoil is strong-brown to brown, friable silt loam to a depth of about 24 inches. It grades to mottled yellowish-brown and gray silty clay loam that is compact and brittle. This lower part of the subsoil is a fragipan that limits the depth of the root zone and restricts the movement of water. Sandstone and shale bedrock is at a depth of more than 4 feet. In plowing, material from the upper part of the subsoil has been mixed with the plow layer. Sheet erosion has removed nearly all of the original surface layer in some places, and patches of subsoil are exposed.

The plow layer is low in organic-matter content. In the more eroded areas, it tends to clod or crust if tilled when too moist or too dry. The natural fertility is moderate, but the response to fertilizer is good. The reaction is medium acid or strongly acid, but lime helps to check the acidity. The moisture-supplying capacity is high, and plants receive sufficient water, except during a dry period.

This soil is suited to corn, soybeans, hay, pasture, and most of the other general crops. If cultivated, it needs a suitable cropping system and specific conservation practices that will effectively control runoff and erosion. Erosion is a moderate hazard. (Capability unit IIIe-2 woodland suitability group 4; wildlife productivity group 2)

Zanesville silt loam, 12 to 20 percent slopes, eroded (ZaD2).—This is a well drained or moderately well drained soil of the Knob Hills. Normally the plow layer is brown, friable silt loam. The subsoil is strong-brown to brown, friable silt loam to a depth of about 24 inches. It grades to mottled yellowish-brown and gray silty clay loam that is compact and brittle. This lower part of the subsoil is a fragipan that limits the depth of the root zone and restricts the movement of water. Sandstone and shale bedrock is at a depth of more than 4 feet. In plowing, material from the upper part of the subsoil has been mixed with the plow layer. Sheet erosion has removed nearly all of the original surface layer in some places, and patches of subsoil are exposed.

The plow layer is low in organic-matter content. In the more eroded areas, it tends to clod if tilled when too moist.

The natural fertility is moderate, but fertilizer helps to increase productivity. The reaction is medium acid or strongly acid, but the response to lime is good. The moisture-supplying capacity is high, and plants receive sufficient water, except during a dry period.

This soil is suited to corn, small grain, hay, and pasture. If cultivated, it is subject to moderately severe erosion. It therefore needs specific conservation practices, plus a cropping system dominated by sod crops, that can reduce runoff and thereby control erosion. (Capability unit IVe-3; woodland suitability group 4; wildlife productivity group 2)

Zipp Series

The Zipp series consists of poorly drained soils that formed in water-deposited, calcareous silt and clay. These soils are on broad flats in the old slack-water area south of Louisville. Their acreage is moderate. Representative profile:

0 to 7 inches, dark-gray silty clay.
7 to 21 inches, dark-gray to gray clay; many brown and dark-brown mottles; strong, blocky structure; sticky and very plastic when wet.
21 to 42 inches +, mottled gray, yellowish-brown, and brown clay; strong, blocky structure; sticky and very plastic when wet.

The texture of the surface layer ranges from silty clay to silty clay loam. In many places the plow layer is neutral in reaction, and the material below the plow layer is alkaline. The alkalinity increases with depth.

Zipp soils are wet, and thus only a small acreage has been cleared. Most of the cleared areas are idle, but a few have been drained and are planted to corn and soybeans. Yields are moderate. Hay and pasture crops that tolerate wetness do better on these soils than any other crops. The potential yield of wood crops is high.

Zipp silty clay (Zp).—This is a poorly drained soil that formed in fine-textured, calcareous sediment in the slack-water flats. The plow layer is dark-gray silty clay or silty clay loam. The subsoil, to a depth of about 21 inches, is gray and mottled brown clay that is plastic and sticky. It grades to mottled gray, yellowish-brown, and brown clay that is very plastic and sticky.

The plow layer is low in organic-matter content, and it is in poor tilth because of its high content of clay. It is likely to clod or crust if plowed at other than during the limited time it is most friable. The natural fertility is moderate, but the response to fertilizer is fairly good, especially after the soil has been drained. In many places the surface layer is nearly neutral in reaction, and the material below the surface layer is alkaline. The alkalinity increases with depth. Only small amounts of lime are needed. The moisture-supplying capacity is moderately high, and plants generally receive sufficient moisture, except during an extended dry period.

This soil is best suited to soybeans and other crops that tolerate wetness. It is not subject to erosion, so it can be cultivated continuously. Excessive wetness in spring and after heavy rains may delay plowing and cultivating. Open ditches and, in some areas, tile drainage can generally reduce wetness. (Capability unit IIIw-4; woodland suitability group 3; wildlife productivity group 3)

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Use of the Soils for Crops and Pasture

This section has several parts. The first part discusses briefly general management and the principles of conservation management. The second explains the capability classification system, and the third discusses use and management of the soils in each of the capability units. The last part gives estimated yields of the principal crops.

General Management and Principles of Conservation Management

In Jefferson County, controlling erosion is the major problem encountered in managing the soils. Other problems include reducing wetness and increasing fertility.

The susceptibility of a soil to erosion depends, above all, on its physical and chemical make up, the steepness and length of its slope, the kind and amount of plants on it, and the conservation practices in use. Some soils erode faster than others because soils vary in depth, structure, texture, and other characteristics that determine erodibility. Also, the rate of erosion increases as the steepness and length of the slope increases. Certain practices, however, such as terracing and stripcropping, break the slope and thereby help to control erosion. Grasses and other close-growing crops sharply reduce runoff, and thus they too help to control erosion.

Generally, specific conservation practices combined with a suitable cropping system can effectively control erosion in most places. As a rule, more practices are put into use as the erosion hazard increases. Also, as the erosion hazard increases, the choice of suitable cropping systems decreases.

A nearly level, deep, productive soil, for example, has no significant erosion hazard and therefore can be cultivated continuously with little or no control measures. A soil that slopes more than 20 percent, on the other hand, can be used only for pasture or woods. Between these two extremes are many different soils, each calling for a suitable cropping system and a specific kind and number of conservation practices.

In other than extreme areas, a more intensive cropping system can be used if additional conservation practices are applied. To illustrate, Crider silt loam on a 5 percent slope that is 170 feet long should have a maximum intensity cropping system consisting of a row crop for 2 years and a meadow crop for 2 years if no conservation practices are applied. But this same soil could be row cropped 2 years out of 3 if it were contoured, and it could be cultivated year after year if it were both contoured and terraced.

Wetness can be reduced in some soils by means of a tile drainage system. In other soils, open ditches are effective. Wherever needed, diversion ditches and levees can prevent overwash and overflow. Crops that tolerate wetness should be grown on wet soils that cannot be drained artificially. Other crops will fail.

The content of organic matter can be maintained or increased by proper residue management, which includes the return of both animal and green manure to the soils. Good tilth can be maintained or improved by plowing or cultivating the soils only during the time that their mois-

This map is one of a set compiled in 1964 as part of a soil survey by the Soil Conservation Service, United States Department of Agriculture, and the Kentucky Agricultural Experiment Station

The first capital letter
soil name. A second c
the slope. Most symb
nearly level soils, suc
soils or land types, su
range of slope. A fina
the soil is eroded or se

SYMBOL	NAME
AsA	Ashton silt loam, 0 to 2 percent slopes
AsB	Ashton silt loam, 2 to 6 percent slopes
BaB	Beasley silt loam, 2 to 6 percent slopes
BaB2	Beasley silt loam, 2 to 6 percent slopes, eroded
BaC2	Beasley silt loam, 6 to 12 percent slopes, eroded
BaD2	Beasley silt loam, 12 to 20 percent slopes, eroded
BeB3	Beasley silty clay loam, 2 to 6 percent slopes, severely eroded
BeC3	Beasley silty clay loam, 6 to 12 percent slopes, severely eroded
BeD3	Beasley silty clay loam, 12 to 20 percent slopes, severely eroded
Br	Breaks and Alluvial land
CaA	Captina silt loam, 0 to 2 percent slopes
CaB	Captina silt loam, 2 to 6 percent slopes
CaC2	Captina silt loam, 6 to 12 percent slopes, eroded
CdB2	Corydon silt loam, 2 to 6 percent slopes, eroded
CmC3	Corydon silty clay loam, 6 to 12 percent slopes, severely eroded
CnC	Corydon very rocky silt loam, 6 to 12 percent slopes
CnD	Corydon very rocky silt loam, 12 to 20 percent slopes
CnE	Corydon very rocky silt loam, 20 to 30 percent slopes
CrC3	Corydon very rocky silty clay loam, 6 to 12 percent slopes, severely eroded
CrD3	Corydon very rocky silty clay loam, 12 to 20 percent slopes, severely eroded
CrE3	Corydon very rocky silty clay loam, 20 to 30 percent slopes, severely eroded
CsA	Crider silt loam, 0 to 2 percent slopes
CsB	Crider silt loam, 2 to 6 percent slopes
CsB2	Crider silt loam, 2 to 6 percent slopes, eroded
CsC	Crider silt loam, 6 to 12 percent slopes
CsC2	Crider silt loam, 6 to 12 percent slopes, eroded
CsC3	Crider silt loam, 6 to 12 percent slopes, severely eroded
CsD2	Crider silt loam, 12 to 20 percent slopes, eroded
DcA	Dickson silt loam, 0 to 2 percent slopes
DcB	Dickson silt loam, 2 to 6 percent slopes
Dn	Dunning silty clay loam
EkA	Elk silt loam, 0 to 2 percent slopes
EkB	Elk silt loam, 2 to 6 percent slopes
En	Ennis cherty silt loam
FaD	Fairmount flaggy silty clay, 12 to 20 percent slopes
FaD3	Fairmount flaggy silty clay, 12 to 20 percent slopes, severely eroded
FaE	Fairmount flaggy silty clay, 20 to 30 percent slopes
FaE3	Fairmount flaggy silty clay, 20 to 30 percent slopes, severely eroded
FaF	Fairmount flaggy silty clay, 30 to 50 percent slopes
Gm	Ginat silt loam
Gn	Gullied land
Gu	Guthrie silt loam
HgD	Holston gravelly silt loam, 12 to 20 percent slopes
HgE	Holston gravelly silt loam, 20 to 30 percent slopes
Hn	Huntington fine sandy loam
Hs	Huntington silt loam
LaB	Lakin loamy fine sand, 2 to 6 percent slopes
LaC	Lakin loamy fine sand, 6 to 12 percent slopes
LaD	Lakin loamy fine sand, 12 to 25 percent slopes
Lb	Lawrence silt loam
Ld	Lindside silt loam
LeD	Litz silt loam, 12 to 20 percent slopes

OIL LEGEND

ach symbol is the first one in the
ol letter, A, B, C, D, E, or F, shows
ithout a slope letter are those of
Melvin silt loam, but some are for
s Gullied land, that have a considerable
nber, 2 or 3, in the symbol, shows that
ely eroded.

SYMBOL	NAME
LmE	Litz–Muskingum silt loams, 20 to 30 percent slopes
LmF	Litz–Muskingum silt loams, 30 to 50 percent slopes
LnB	Loring silt loam, 2 to 6 percent slopes
LnC2	Loring silt loam, 6 to 12 percent slopes, eroded
LoC2	Loring–Crider silt loams, 6 to 12 percent slopes, eroded
LsC2	Lowell silt loam, 6 to 12 percent slopes, eroded
Ma	Made land
MdB2	Markland silt loam, 2 to 6 percent slopes, eroded
MdC2	Markland silt loam, 6 to 12 percent slopes, eroded
MdE	Markland silt loam, 12 to 30 percent slopes
Mg	McGary silt loam
Mm	Melvin silt loam
Mn	Melvin silty clay loam
Mo	Melvin silt loam, overwash
MpB	Memphis silt loam, 2 to 6 percent slopes
MpC2	Memphis silt loam, 6 to 12 percent slopes, eroded
MpD2	Memphis silt loam, 12 to 20 percent slopes, eroded
MpE2	Memphis silt loam, 20 to 30 percent slopes, eroded
MuF	Muskingum stony soils, 30 to 50 percent slopes
Ne	Newark silt loam
OcD	Otway silty clay, 12 to 20 percent slopes
OcD3	Otway silty clay, 12 to 20 percent slopes, severely eroded
Pd	Purdy silt loam
Rb	Robertsville silt loam
RcE	Rockcastle silt loam, 15 to 30 percent slopes
Rd	Rock land
RuA	Russellville silt loam, 0 to 2 percent slopes
RuB	Russellville silt loam, 2 to 6 percent slopes
RuB2	Russellville silt loam, 2 to 6 percent slopes, eroded
RuC2	Russellville silt loam, 6 to 12 percent slopes, eroded
ScA	Sciotoville silt loam, 0 to 2 percent slopes
ScB	Sciotoville silt loam, 2 to 6 percent slopes
ScC2	Sciotoville silt loam, 6 to 12 percent slopes, eroded
SfA	Sequatchie fine sandy loam, 0 to 2 percent slopes
SfB	Sequatchie fine sandy loam, 2 to 6 percent slopes
SfC2	Sequatchie fine sandy loam, 6 to 12 percent slopes, eroded
ShB	Shelbyville silt loam, 2 to 6 percent slopes
Ta	Taft silt loam
Ty	Tyler silt loam
Wb	Weinbach silt loam
WcF	Westmoreland–Litz–Muskingum complex, 30 to 50 percent slopes
WeA	Wheeling silt loam, 0 to 2 percent slopes
WeB	Wheeling silt loam, 2 to 6 percent slopes
WeC2	Wheeling silt loam, 6 to 12 percent slopes, eroded
WeD2	Wheeling silt loam, 12 to 20 percent slopes, eroded
WeE2	Wheeling silt loam, 20 to 30 percent slopes, eroded
WmB	Woolper silty clay loam, 2 to 6 percent slopes
WmC2	Woolper silty clay loam, 6 to 12 percent slopes, eroded
ZaB	Zanesville silt loam, 2 to 6 percent slopes
ZaC2	Zanesville silt loam, 6 to 12 percent slopes, eroded
ZaD2	Zanesville silt loam, 12 to 20 percent slopes, eroded
Zp	Zipp silty clay

Soil map constructed 1964 by Cartographic Division, Soil Conservation Service, USDA, from 1960 aerial photographs. Controlled mosaic based on Kentucky plane cordinate system, south zone Lambert conformal conic projection. 1927 North American datum.

United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Kentucky Natural Resources
and Environmental
Protection Cabinet and
Kentucky Agricultural
Experiment Station

Reference 20

Soil Survey of Bullitt and Spencer Counties, Kentucky

1 560 000 FEET
212 000 FEET
(Joins lower left)
OtB
OtC
EkC
NhB
CrB
CrC
CrD
ZnC
Pt
65
145

SOIL LEGEND

The first letter, always a capital, is the initial letter of the soil name. The second letter is a small letter connotative of soil name if possible. The third, if used, is a capital letter and indicates the slope class. Symbols without a slope letter are nearly level, except for pits which is not a soil and has variable slopes. If the number 3 is added to the symbol, it indicates severe erosion. Symbols without a number indicate none to moderate erosion.

SYMBOL	NAME
BeB	Beasley silt loam, 2 to 6 percent slopes
BeC	Beasley silt loam, 6 to 12 percent slopes, eroded
BeD	Beasley silt loam, 12 to 20 percent slopes, eroded
BfC3	Beasley silty clay loam, 6 to 12 percent slopes, severely eroded
BfD3	Beasley silty clay loam, 12 to 20 percent slopes, severely eroded
Bo	Boonesboro silt loam, frequently flooded
CaB	Caneyville silt loam, 2 to 6 percent slopes
CaC	Caneyville silt loam, 6 to 12 percent slopes, eroded
CbD	Caneyville-Beasley-Rock outcrop complex, 12 to 30 percent slopes
CnD	Caneyville-Rock outcrop complex, 6 to 20 percent slopes
CnE	Caneyville-Rock outcrop complex, 20 to 40 percent slopes
CrB	Crider silt loam, 2 to 6 percent slopes
CrC	Crider silt loam, 6 to 12 percent slopes, eroded
CrD	Crider silt loam, 12 to 20 percent slopes, eroded
EcC	Eden silty clay loam, 6 to 20 percent slopes, eroded
EdE3	Eden flaggy silty clay, 20 to 30 percent slopes, severely eroded
EkA	Elk silt loam, 0 to 2 percent slopes
EkB	Elk silt loam, 2 to 6 percent slopes
EkC	Elk silt loam, 6 to 12 percent slopes
ElA	Elk silt loam, occasionally flooded, 0 to 2 percent slopes
ElB	Elk silt loam, occasionally flooded, 2 to 6 percent slopes
ElC	Elk silt loam, occasionally flooded, 6 to 12 percent slopes
FaC	Faywood silt loam, 6 to 12 percent slopes, eroded
FdD	Faywood silty clay loam, 12 to 20 percent slopes, eroded
FkF	Faywood-Beasley-Rock outcrop complex, 25 to 60 percent slopes
FlE	Faywood-Cynthiana complex, 12 to 30 percent slopes
FnF	Faywood-Fairmount-Woolper complex, 30 to 60 percent slopes
GmF	Garmon silt loam, 25 to 60 percent slopes
HaC	Hagerstown silt loam, 6 to 12 percent slopes, eroded
La	Lawrence silt loam, rarely flooded
Le	Lawrence silt loam
LfE	Lenberg-Carpenter complex, 20 to 40 percent slopes
LoB	Lowell silt loam, 2 to 6 percent slopes
LoC	Lowell silt loam, 6 to 12 percent slopes, eroded
LsC3	Lowell silty clay loam, 6 to 12 percent slopes, severely eroded
MaB	Markland silt loam, rarely flooded, 2 to 6 percent slopes
MbD3	Markland silty clay, occasionally flooded, 10 to 30 percent slopes, severely eroded
Mc	McGary silt loam, rarely flooded
Mv	McGary Variant silt loam, rarely flooded
Mo	Montgomery silty clay loam
Ne	Newark silt loam, frequently flooded
NhA	Nicholson silt loam, 0 to 2 percent slopes
NhB	Nicholson silt loam, 2 to 6 percent slopes
NhC	Nicholson silt loam, 6 to 12 percent slopes
No	Nolin silt loam, frequently flooded
OtA	Otwell silt loam, 0 to 2 percent slopes
OtB	Otwell silt loam, 2 to 6 percent slopes
OtC	Otwell silt loam, 6 to 12 percent slopes
OwB	Otwell silt loam, occasionally flooded, 2 to 6 percent slopes
Pt	Pits
Sg	Sensabaugh gravelly loam, occasionally flooded
ShB	Shelbyville silt loam, 2 to 6 percent slopes
TrC	Trappist silt loam, 6 to 12 percent slopes
TrD	Trappist silt loam, 12 to 30 percent slopes, eroded
WoB	Woolper silty clay loam, 2 to 6 percent slopes
WoC	Woolper silt clay loam, 6 to 12 percent slopes
ZaB	Zanesville silt loam, 2 to 6 percent slopes
ZaC	Zanesville silt loam, 6 to 12 percent slopes

CULTUR

BOUNDARIES

National, state o

County or parish

Minor civil divisi

Reservation (nati
state forest or
and large airp

Land grant

Limit of soil surv

Field sheet matc

AD HOC BOUNDA

Small airport, air
cemetery, or f

STATE COORDINA

LAND DIVISION C
(sections and lan

ROADS

Divided (median
if scale permit

Other roads

Trail

ROAD EMBLEM &

Interstate

Federal

State

County, farm or r

RAILROAD

POWER TRANSMIS
(normally not sho

PIPE LINE
(normally not sho

FENCE
(normally not sho

LEVEES

Without road

With road

With railroad

DAMS

Large (to scale)

Medium or small

PITS

Gravel pit

Mine or quarry

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

ALT 001 001066

Reference 21

GEOSCIENCES RESEARCH ASSOCIATES, INC.

geological, hydrological, geotechnical and environmental consulting

DRAFT REPORT

Hydrologic Investigation at the A.L. Taylor Site

Bullitt County, Kentucky

Geosciences Research Associates, Inc.
414 South Walnut Street
Bloomington, Indiana
47401

April 17, 1984

ALT 001 001067

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3 Summary of Field Permeability Tests

4 Field Water Quality Measurements

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DRAFT REPORT

Hydrologic Investigation at A.L. Taylor Site,
Bullitt County, Kentucky

Geosciences Research Associates, Inc.
April 17, 1984

Introduction

The following report describes the hydrologic investigation conducted by Geosciences Research Associates, Inc. (Geosciences) at A.L. Taylor Landfill Site, Bullitt County Kentucky, January-March, 1983. The investigation was undertaken to provide U.S. EPA, Region IV with additional geologic and hydrologic data concerning the modified on-site containment alternative as outlined by TenEch (1983) Final Design Report for Remedial Action at the A.L. Taylor Hazardous Waste Disposal Site. In response to the TenEch (1983) report, U.S. EPA requested additional data concerning hydrologic conditions at the site in order to approve implementation of the TenEch remedial action design plan. In a letter from Thomas W. Devine (Oct. 17, 1983) U.S. EPA requested that the following determinations be made:

1) Determine the permeability in the overburden/weathered shale zone between the disposal pits and Wilson Creek.

2) Determine the horizontal extent of contaminant migration between the disposal pits and Wilson Creek.

3) Determine ground water flow direction and flow velocity of ground water on site and downgradient of the site.

U.S. EPA felt that the above determinations were necessary to adequately justify elimination of a leachate collection system as per the TenEch (1983) remedial action design report. Geosciences outlined a scope of work designed to address these concerns. Locations for five (5) proposed borings on site were selected during a site visit November 4, 1983 attended by representatives from U.S. EPA, Kentucky Department of Natural Resources and Environmental Protection (DNREP), Reliance Universal Incorporated, Ford Motor Company, George W. Whitesides Company, and Geosciences Research Associates, Inc. On December 2, 1983, Geosciences submitted a formal technical proposal for soil and ground water testing and permeability determination at the Taylor Site. With minor revision, this proposal was accepted for implementation by U.S. EPA in a letter from A. Shane Hitchcock, January 19, 1984. Initial work at the site,

consisting of soil sampling and monitoring well installation was completed January 31 to February 3, 1984. Water sampling and field permeability testing were conducted on February 15 and 16. Laboratory permeability testing was conducted on undisturbed Shelby Tube samples by Milton M. Greenbaum Associates, Louisville Kentucky. Volatile Organics Analysis on soil and water samples were completed by Environmental Consultants, Inc., Clarksville, Indiana.

Background and Scope of Work

A previous geologic investigation of the A.L. Taylor site (Ecology and Environment, 1982) has suggested that the Taylor site is underlain by silty and clayey soils developed in loess and residual materials weathered from siltstone and shale bedrock. The soil material has been interpreted to overlie weathered shale which grades into impermeable New Providence Shale bedrock. The weathered shale zone was interpreted by Ecology and Environment (1982) as 1 to 5 feet thick, and has been considered to be the most likely avenue for any horizontal contaminant migration. Along the eastern side of the Landfill adjacent to the existing diversion ditch previous borings by Ecology and Environment (1982) (Borings KL-8, L-11, L-12, K-16), revealed the top of the weathered shale, apparently distinguished by its greenish color to be 8 to 11 feet beneath the surface. All of these borings terminated in the weathered shale zone. No boring data were gathered by Ecology and Environment in the area between Wilson Creek and the existing diversion ditch.

Borings reported by U.S. EPA (1979) east of the diversion ditch (Borings CC1 and CC6) revealed at least 14.5 to 16 feet of unconsolidated material overlying shale bedrock, and suggested that somewhat thicker unconsolidated materials were present between the diversion ditch and Wilson Creek. These geologic materials would be relied upon to provide lateral containment of contaminants on site under the TenEch design plan. It was requested by U.S. EPA that information regarding the geologic and hydrologic properties of these materials be obtained to support the TenEch (1983) on-site containment alternative. The present study was directed toward that end.

Some modification of the proposed boring scheme was required as geologic information was gathered during the study. These changes were made in consultation with Kentucky DNREP observer, Mr. Barry Burris. The order in which the borings were completed was altered somewhat because of the extremely wet soil conditions and the necessity of moving the drilling rig from site to site by

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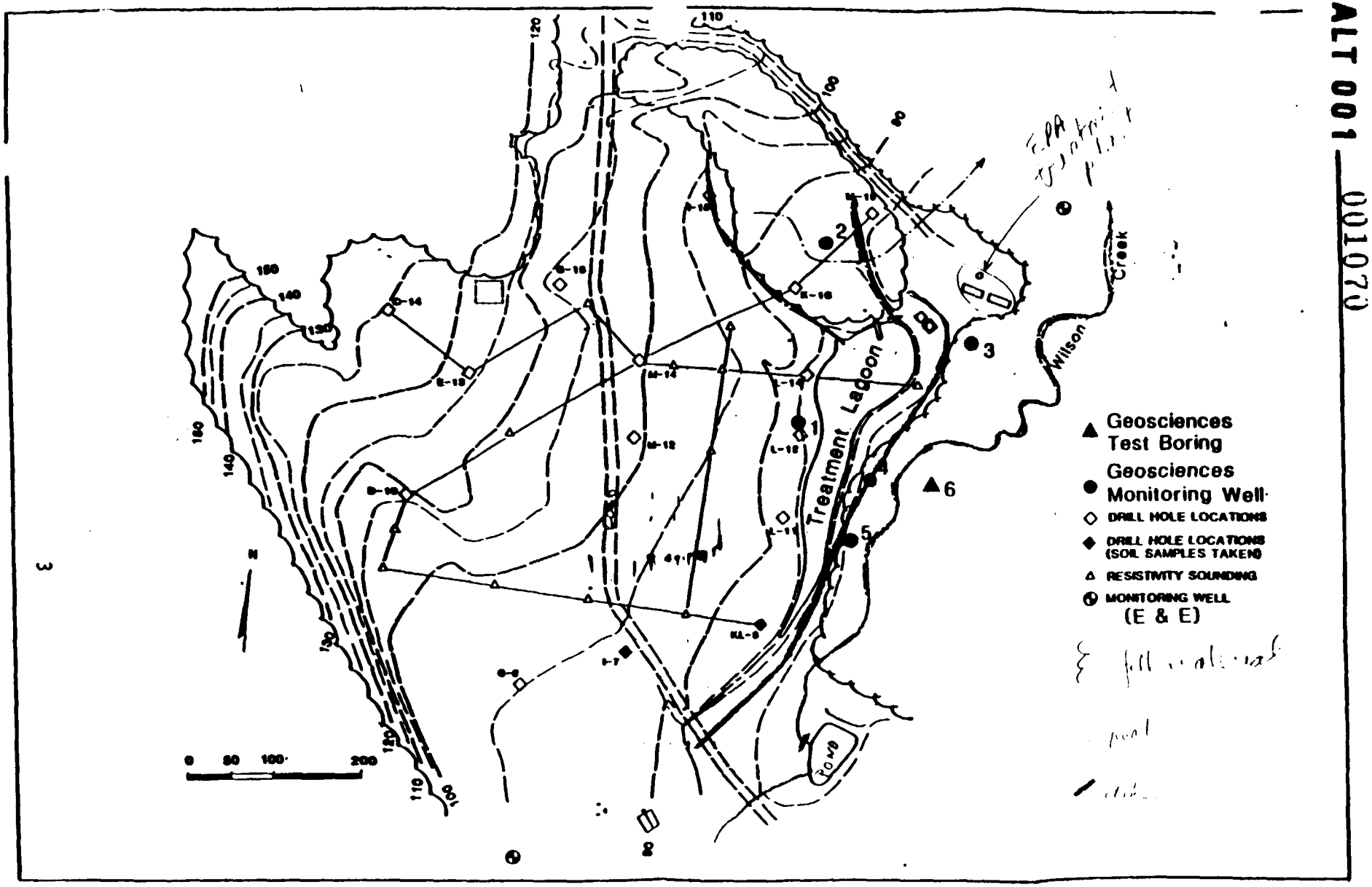

Figure 1. Map of Taylor Site showing Locations of Test Borings and Monitoring Wells. Map modified from TenEch, August 1983, Final Design Report.

bulldozer. It was determined that the weathered shale zone of principal interest during the study could be successfully sampled by Shelby Tube. Therefore, the split barrel rock coring equipment was utilized only on the first boring, and all subsequent samples for laboratory permeability determination were obtained by Shelby Tube.

One boring was made between the disposal area and the existing diversion ditch and a second was made northwest of the treatment lagoon. Three other borings were made between Wilson Creek and the diversion ditch. All of these borings were completed as monitoring wells in the weathered shale zone except Well 4 which was completed in a shallower soil zone An additional boring was made east of Wilson Creek to gather information on the horizontal extent of contaminant migration. The boring was not part of the original boring plan and was not completed as a monitoring well. The locations of all borings and observation wells are shown in Figure 1.

Drilling and Soil Sampling Procedures

Borings were completed and wells installed during the period January 31 to February 3, 1984. Drilling and sampling techniques largely followed the revised November 15, 1983 scope of work. All borings were completed with a Mobil B series drilling rig equipped for push and drive sampling, as well as air coring through 7 5/8" hollow stem auger. Soil samples for geologic description were taken from driven continuous 18" split spoon cores. Soil samples for laboratory permeability analyses were obtained from pushed Shelby Tube samples. Soil samples for volatile organic analysis were taken from the split spoon cores.

Hollow stem augers, rods, and split spoon samplers were thoroughly steam cleaned after each boring was completed. Split spoon samplers were steam cleaned, rinsed in acetone, and finally rinsed in organic-free deionized water between samples. Care was taken to avoid placing any drilling or sampling equipment directly on the ground surface. To avoid surface contamination of subsurface soil and water, the following procedure was followed to commence each boring that was to be completed as an observation well. The boring was augered to a depth of 1.5 to 3.0 feet using a 9 1/2" hollow stem auger. The auger was removed from the hole, and the hole was manually cleaned out and enlarged slightly to accommodate a nominal 10" PVC surface casing. The casing was pushed into the boring and seated 0.2-0.3' into the hole bottom. The hole

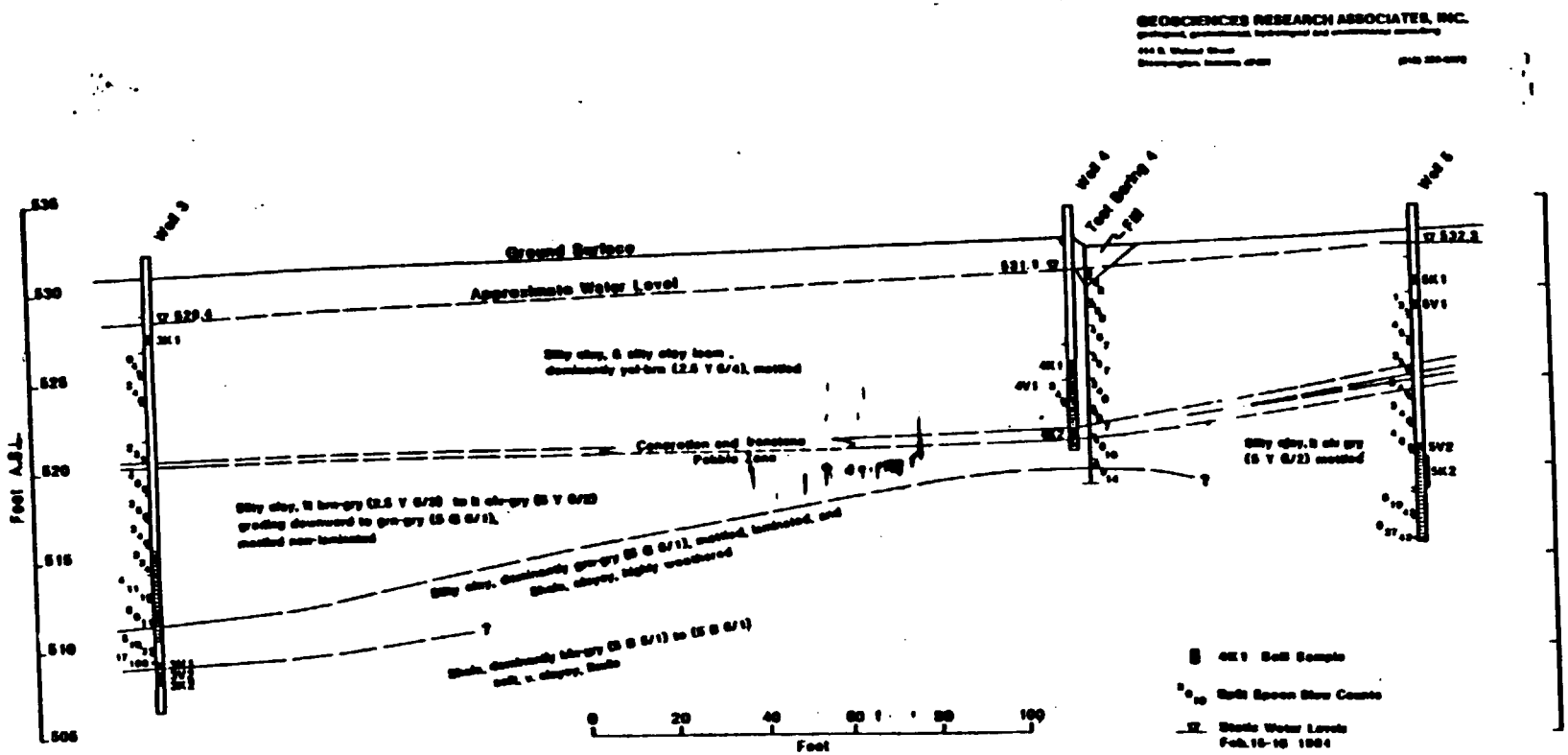

Figure 2. Geologic Cross Section Through Monitoring Wells 3,4 & 5, Looking ESE.

was then cleaned by hand to expose undisturbed soil in the hole bottom. The boring then proceded using standard Shelby Tube and split spoon methods through the hollow stem auger. Monitoring wells were completed using nominal 2-inch I.D. flush joint PVC pipe and commercial 0.010 inch slot PVC screen and sand pack. Annular space above the sand pack was filled to the surface with bentonite slurry.

Samples for laboratory analysis of volatile organic compounds (V samples) and laboratory permeability determination (K samples) were obtained at the depths indicated in Figures 2, 3, and Table 1. Soil samples for volatile organic analysis were obtained from clean split spoon samples, and were immediately sealed in cleaned, baked glass jars with aluminum foil liners after opening of the sampler. Samples were scraped of any surface contamination, but were disturbed as little as possible. Head space in the jar was as small as possible. Samples were stored on ice until transport to the laboratory. Samples for laboratory permeability analysis were sealed in the Shelby Tube samplers immediately after collection. About 0.2' foot of soil material was removed from the bottom end of each sample tube for description, and both the top and bottom of the tube were sealed with wax and wrapped in plastic. Samples were transported to the lab in an upright position.

Geologic Description

Sample descriptions were made for each boring (see Appendix) and were used to compile two geologic cross sections (Figures 2 and 3). The unconsolidated materials east of the existing diverison ditch are dominantly silty clay loam and silty clay in texture, and a fairly consistant sequence of materials from the surface down was found in all four borings in the area. The upper 7 to 11 feet of the unconsolidated materials consists of silty clay and silty clay loam, dominantly yellowish brown (2.5 Y 6/4) but highly mottled and variable in color. The materials are generally soft in consistance. At 7 to 11 foot depth in the basal part of this material is a thin persistent concretion and ironstone pebble zone. This zone, characterized by a small percentage of greater than 2 mm size fraction was observed in all borings east of the diversion ditch. Theironstone fragments are subangular flattened fragments apparently derived from exfoliation type weathering of siderite nodules contained in the New Providence Shale. Several nodules weathering in this manner are exposed in the clay borrow area along the southwestern edge of the Taylor property. The siderite nodules weather rapidly where exposed at the surface, forming concentrations of ironstone fragments that litter the ground surface. The ironstone

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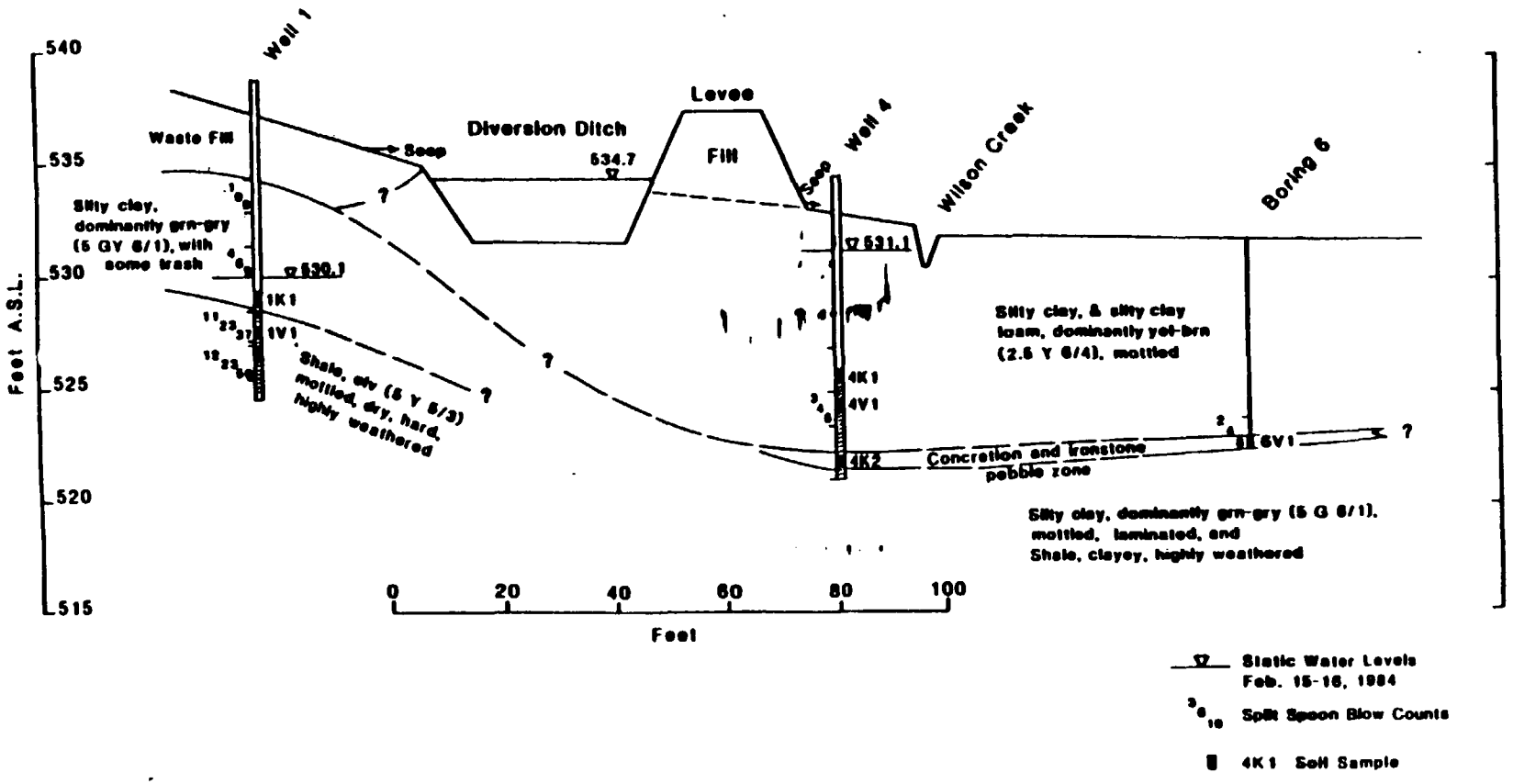

Static Water Levels Feb. 15-16, 1984

Split Spoon Blow Counts

4K1 Soil Sample

Figure 3. Geologic Cross Section Through Monitoring Wells 1 & 4 and Test Boring 6, Looking North.

TABLE 1

Sample Inventory

Boring No.	Location	Elevation (Casing) (Ground)	Water Sample	Soil Samples (Depth-ft)	Lab Permeability Samples (Depth-ft)
1	4+33 H+39	539.0 537.6	1W	-	1K1 (8.1-8.6)
2	6+42 H+70	540.7 539.5	-	2V1 (4.8-5.2) 2V2 (9.6-10.0)	2K1 (3.0-3.5) 2K2 (8.0-8.5)
3	5+26 J+43	532.2 530.8	3W	-	3K1 (3.0-3.5) 3K2 (22.4-22.6)
4	3+62 I+14	534.7 532.9	4W	-	4K1 (7.0-7.5) 4K2 (10.8-11.3)
5	2+93 H+94	534.5 533.1	5W	-	5K1 (2.8-3.3) 5K2 (12.7-14.7)
6	3+67 I+88	- 531.9	-	6V1 (8.9-9.3)	-

Boring 5 was drilled to split spoon refusal to a depth of 17.7' below datum (17.4' below surface). Although split spoon refusal was encountered at shallower depth than Boring 3, a similar sequence of unconsolidated materials was encountered. A strong solvent smell was noted in shallow samples from Boring 5, whereas materials below the ironstone pebbly zone bore little or no contaminant odor. Upon discussions with Mr. Barry Burris (Kentucky DNREP) and Shane Hitchcock (U.S. EPA) it was agreed to complete Well 5 as an observation well in the weathered shale zone. It was clear that a considerable thickness of alluvial and colluvial materials existed above weathered shale and shale residuum east of the diversion ditch, and that contaminants occurred in the shallow alluvial/colluvial materials in this area.

Concern was expressed that the soil materials above and including the ironstone zone were the most likely avenues for horizontal contaminant movement. Consequently, in consultation with Mr. Barry Burris, it was decided to drill a test hole near the proposed location of Boring 4 to bbtain geologic data and to establish the presence and depth of the ironstone zone. Boring 4 (test) was drilled using hollow stem augers and continuous split spoon samples. Stong solvent odor was evident in the soil samples down to a depth of 3.0', and gradually decreased to a depth of 10.5 feet. Solvent smell to soil samples in deeper parts of Boring 4 is probably related to contaminated water in the hole derived from shallower soil horizons. The ironstone zone was encountered at a depth of 10.0', overlying silty clay weathered shale. The drill rig was moved approximately 12' north to the location of Boring 4, from which samples for volatile organic analysis and laboratory permeability were obtained. The boring was made to a total depth of 12.0' into the top of the weathered shale zone. The boring was completed as an observation well (Well 4), and was screened from 7 to 12 feet below surface in the lower part of the alluvial/colluvial materials. Samples for laboratory permeability determination were obtained from the lower part of alluvial/colluvial materials including the ironstone and concretion zone.

To determine the horizontal extent of contaminated soil materials east of the existing diversion, Boring 6 was made 70 feet east of Boring 4 on the opposite side of Wilson Creek. The boring was drilled using hollow stem auger to a depth of 8.0'. At this point, a clean split spoon sample was obtained. The top of the ironstone pebble zone was noted at a depth of 9.1', and a sample of this zone was obtained for volatile organic analysis (6V1). This boring was not completed as an observation well.

fragments are a product of surface or near surface weathering, and their presence at depth in the area east of the diversion ditch may be explained if the overlying soil materials have been transported. The persistent zone of ironstone fragments in the unconsolidated materials is interpreted to represent a basal coarse fraction lag deposited along an old land surface. The interpretation is here offered that the silty clay and silty loam above the ironstone zone is alluvial and colluvial in origin and does not constitute in situ weathered New Providence Shale (Figures 2 and 3).

The ironstone zone directly overlies a relatively sharp contact between silty clay and silty clay loam alluvial and colluvial materials and underlying silty clay that is most probably derived from in situ weathering of New Providence Shale. Beneath the ironstone zone, light brownish gray (2.5 Y 6/3) to light olive gray (5 Y 6/2) silty clay grades downward to highly weathered shale that contains well defined horizontal laminations in color and structure. The laminated material is interpreted to be the weathered shale of previous site reports. Color banding in this zone is largely attributed to oxidation along bedding surfaces. The weathered shale in turn grades downward to non-oxidized fissile bluish gray shale that is largely unweathered. The shale was encountered at a depth of 21 feet in Boring 3. The dashed lines delineating weathered shale and shale in Figures 2 and 3 should not be interpreted as geologic boundaries, but represent the approximate upper and lower boundaries of the weathered shale zone. The lower boundary of the weathered shale generally corresponds to the maximum feasible depth of split spoon sampling, and the upper boundary to the highest occurrence of readily recognizable shaley lamination. Continuous samples from each boring were saved for further laboratory examination.

In the first boring completed (Well 3), a shallow permeability sample was taken from the upper alluvial/colluvial materials. Below the ironstone zone, approximately 9' of residual silty clay was encountered. A relatively thin zone of laminated silty clay was encountered that graded downward into largely unweathered shale. A rock core was obtained by air rotary methods from 21.7-24.4' depth. The purpose of this core was to obtain a sample of the weathered shale for permeability analysis. The core revealed impermeable, largely unweathered shale at this depth, and the sample obtained (3K2) was from the uppermost portions of the shale bedrock. The boring was completed as a monitoring well with screen set opposite the upper portion of the weathered shale and lower portion of the overlying silty clay.

Boring 2 was located northwest of the treatment lagoon, and the "test" boring approach was again used at this location. Small ironstone pebbles were noted in colluvium down to a depth of 7.5 feet. Below 7.5 feet to the total depth of the boring at 13.5 feet, laminated clay and shale occurred. The materials are interpreted to be wholey residual and colluvial in origin. The material below 7.5' depth was very dry and was interpreted as weathered shale. Samples of the colluvial and weathered shale materials were obtained for volatile organic and permeability analysis from Boring 2, located approximately 10 feet northest of Boring 2 (test). Boring 2 was completed as an observation well (Well 2) in the weathered shale zone. This well produced no water.

Boring 1 was completed immediately below the "toe" of the landfill adjacent to the existing treatment lagoon in an area that was originally believed to be relatively undisturbed by landfill or the 1979 EPA emergency response activities. Two attempts to start this boring revealed that the surface was underlain by an assortment of common trash consisting of plastic, wire, bricks, concrete, and steel. A total thickness of 3.0' of this material was augered through on the third attempt. A 4.0' length of 10" surface casing was set through the fill material, and the hole was bailed and hand cleaned. A slight chemical smell was apparent in the fill material. At 3.0' depth, sampling commenced by split spoon. The samples revealed silty clay overlying weathered shale at a depth of 8 to 9 feet. The driller reported coarse materials, probably trash, to a depth of 6.0', and sample recovery to that depth was very poor. Samples revealed weathered shale below 8 to 9 feet depth to the total depth of the boring at 13.0'. The bottom materials below 12.0' depth were very dry. Boring 1 was completed as an observation well in the weathered shale zone and was screened in the interval 8.0 to 13.0'.

Laboratory Permeability Testing

Shelby Tube samples were cut in the laboratory and extruded samples were placed in a consolidometer and saturated. Permeability determinations were by the falling head method and followed U.S. Army Corps of Engineers (1980) EM 1110-2-1906. Results are expressed as the coefficient of permeability in cm/sec at 20° C. Results are thus directly comparable to results from the field permeability determinations. It should be noted that laboratory permeability determinations measure permeability along the vertical coordinate, whereas field permeability methods measure average permeability in a horizontal

(radial) direction or an average spherical permeability possessing both a horizontal and vertical component. For many geologic materials, horizontal permeability is considerably greater than vertical permeability. Laboratory permeability results are tabulated in Table 2.

Field Permeability Testing

Field permeability tests were performed on Wells 1, 3, 4 and 5 on February 15-16, 1984. Well 2 had been dry since installation, and could not be used for permeability testing. The four remaining wells were developed by pumping or bailing until dry during the period February 1-3, and again on February 7. The initial development showed that only Well 3 would yield sufficient water to allow pump testing, and that even this well would sustain only the most minimal pump rate. The extremely low yields of Wells 1, 4 and 5 meant that instantaneous withdrawal methods (bail tests) would be the only viable means of defining hydrologic characteristics for these wells.

A "mini-rate" single well pump test of Well 3 was conducted on February 15. A peristaltic pump was used to withdraw ground water from the well at a rate of 0.15 gpm as measured in a calibrated bucket. Drawdown in the well was measured with a clean electric sensor. Static water level was 3.8 feet below the top of casing prior to pumping, and declined to about 13.8 feet (10 feet drawdown) after 3 hours when the pump test was concluded. A plot of drawdown versus time (Figure 4) shows a good correlation with type curves considering significant casing storage effects (Papadopulos & Cooper, 1967). This interpretation method assumes radial flow to a well with finite storage volume, and is strictly valid only under confined conditions. However, due to the very tight fine-grained nature of the soil materials, and consequent low water yielding capacity (specific yield) the Papadopulos and Cooper (1967) method may be reasonably applied. The field data indicate that, initially, all water removed from the observation well was derived from casing storage. The field time-drawdown curve becomes more gently sloped with time as greater amounts of water are yielded from the soil.

The permeability determined from Papadopulos and Cooper (1967) was checked against the specific capacity calculation approach of Walton (1970). The Specific capacity, in gpm/ft. of drawdown, is calculated at the end of the pumping test, and the value of specific capacity is used to calculate transmissivity and hydraulic conductivity. The results of the two different

TABLE 2

A.L. Taylor Site

Laboratory Permeability Testing

Well	Shelby Tube Sample	Depth	Description	Permeability (cm/sec)
1	1K1	8.1'-8.6'	Slty cly, olv-yel (2.5 Y 6/6) with com. gry (N 6/) and grn-gry (5 GY 6/1) mottles	1.7×10^{-8}
2	2K1*	3.0'-3.5'	Slty cly, tan with gry mottles, moist	4.5×10^{-7}
2	2K2*	8.0'-8.5'	Shale (weathered), grn-gry, with numerous fractures	2.0×10^{-7}
3	3K1	3.0'-3.5'	Slty cly, lt yel brn (2.5 Y 6/4), with com. lt gry (N 7/) mottles	1.3×10^{-7}
4	4K1	7.0'-7.5'	Slty cly, lt brn-gry (2.5 Y 6/2) w/com. faint brn-yel (10 YR 6/6) mottles, solvent odor	2.5×10^{-7}
4	4K2*	10.8'-11.3'	Cly slt, tan and gry with black gravel, moist, solvent odor	5.3×10^{-7}
5	5K1	2.8'-3.3'	Slty cly, lt yel-brn (2.5 Y 6/4) w/com. faint lt gry (N 7/) mottles, solvent odor	7.0×10^{-7}
5	5K2	12.7'-14.7'	Slty cly, brn-yel (10 YR 6/6), with com. faint grn-gry (5 G 5/1) mottles and iron staining	4.5×10^{-7}

Well	Core Sample	Depth	Description	Permeability
3	3K2	22.4'-22.6'	Shale, grn-gry (5 BG 5/1), hard, fissile	6.3×10^{-8}

* Samples described by Milton Greenbaum Associates. Other sample descriptions by Geosciences Research Associates.

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A.L.Taylor Site

Well 3 Pumping Test 2/15/84

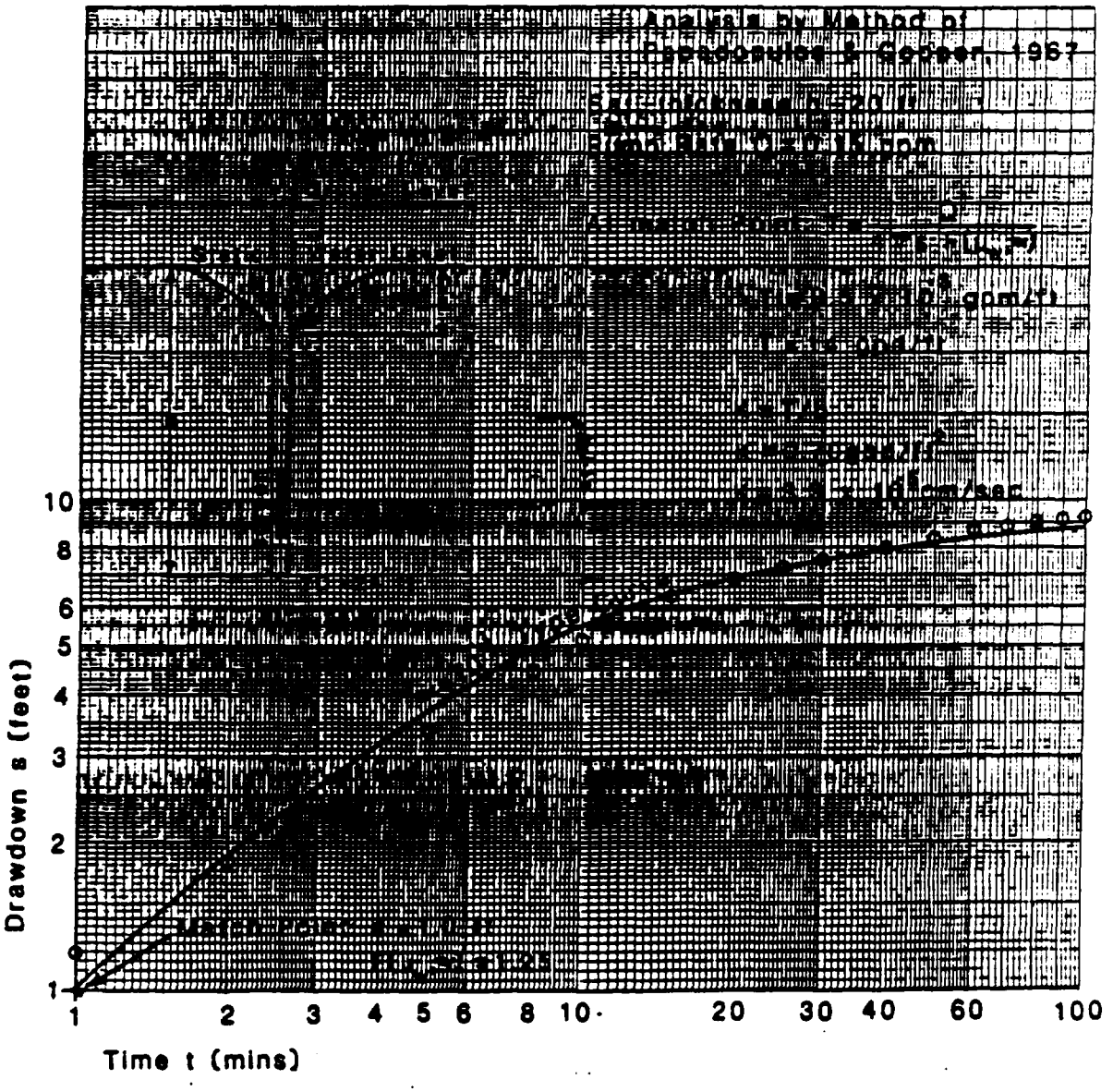

Figure 4. Time-drawdown Curve from Well 3 and Calculation of Hydraulic Conductivity.

methods are consistent and are presented in Table 3. The calculated hydraulic conductivity values are both close to 3×10^{-5} cm/sec., typical of fine grained clay and silt rich materials. A similar pumping test was attempted on Well 5 using an even lower pump rate, but was terminated after 63 minutes when the casing had been pumped completely dry.

Bail tests were conducted on Wells 1, 4, and 5 on February 16, 1984. A known volume of ground water was instantaneously withdrawn from each well using a teflon bailer, and recovery rate was monitored. Recovery data for Well 4 and Well 5 were converted to fraction of the initial drawdown remaining to be recovered (H/H_0), and are shown in Figures 5 and 6. Thus, at the instant of withdrawal, $H/H_0=1$, and at full recovery $H/H_0=0$. The methods of Cooper and others (1967) and Hvorslev (1951) were used to analyze bail test recovery data for Wells 4 and 5 (Figures 5 and 6). The Cooper curve matching method assumes confined conditions, whereas the Hvorslev method is applicable to water table situations. Results for both methods of analysis are shown in Table 2. An average of the two hydraulic conductivity values calculated for Well 4 is about 3×10^{-6} cm/sec, and for Well 5 is about 1×10^{-5} cm/sec.

The recovery data for Well 1 was so erratic that no interpretation was possible. This apparently results from the extremely low yield of this well as compared with the others. Also, the top of the column of water standing in Well 1 was only 5.6 feet above the bottom of the well. Upon withdrawal of the bailer, the upper portion of the 6 foot thick sand pack was dewatered, thus violating the assumption of confinement. No value of hydraulic conductivity could be calculated from this test, but it is believed that the materials surrounding Well 1 are far less permeable than those penetrated by the other wells.

Ground Water Sampling and Analysis

Water sampling was performed on February 16, 1984, about 2 weeks following well installation and development. Aquifer tests were performed in conjunction with purging, immediately prior to sampling. This sequence was intended to assure that ground water would be drawn into each well, yielding representative samples for chemical analysis.

Samples were taken with a clean teflon bailer suspended from nylon monofiliment line to avoid loss of volatiles. Well 4 was known to be contaminated with solvents, since water withdrawn during development had a

TABLE 3

Summary of Field Permeability Tests

Well	Test Type	Analysis Method	Hydraulic Conductivity	Remarks
1	Bail Test	-	-	Very slow recovery; data analysis not possible.
2	None	-	-	Dry hole.
3	Pump Test (single well)	Papadopulos & Cooper, 1967	3.3×10^{-5} cm/sec	Three hour duration pump test; pump rate = 0.15 gpm.
		Walton, 1970 (Specific Capacity)	2.4×10^{-5} cm/sec	
4	Bail Test	Cooper et al, 1967	1.8×10^{-6} cm/sec	72% Recovery after 4.1 hours.
		Hvorslev, 1951	5.3×10^{-6} cm/sec	
5	Bail Test	Cooper et al, 1967	9.1×10^{-6} cm/sec	99% Recovery after 5.6 hours.
		Hvorslev, 1951	1.2×10^{-5} cm/sec	
	Pump Test (single well)	-	-	Pump test aborted after 63 mins. when well went dry.

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A.L. Taylor Site 2/16/84
Bail Tests, Wells 4 & 5

Analysis by method of Cooper et al, 1967

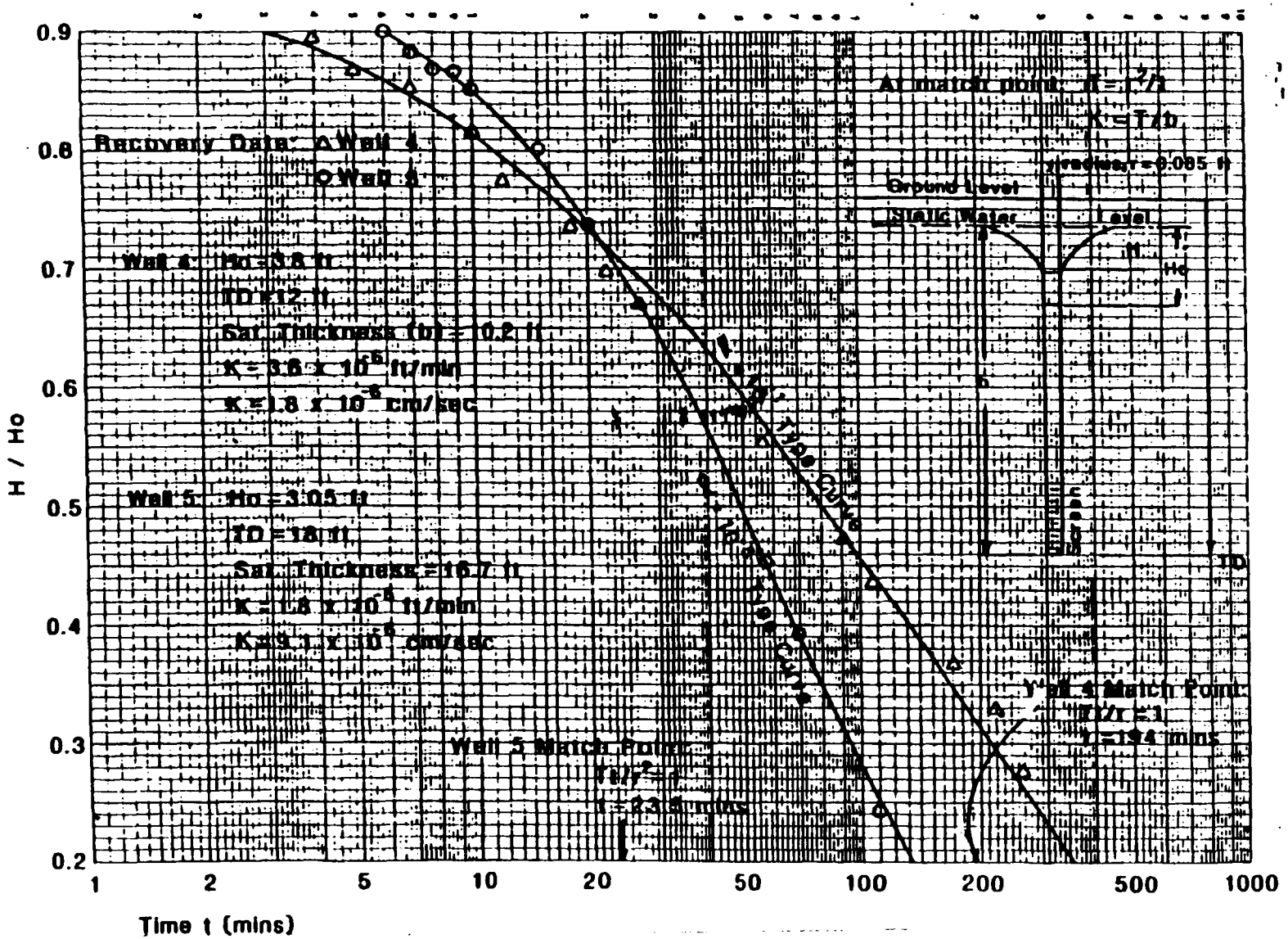

Figure 5. Recovery Curves from Bail Tests on Wells 4 and 5. Analysis from Cooper and others (1967).

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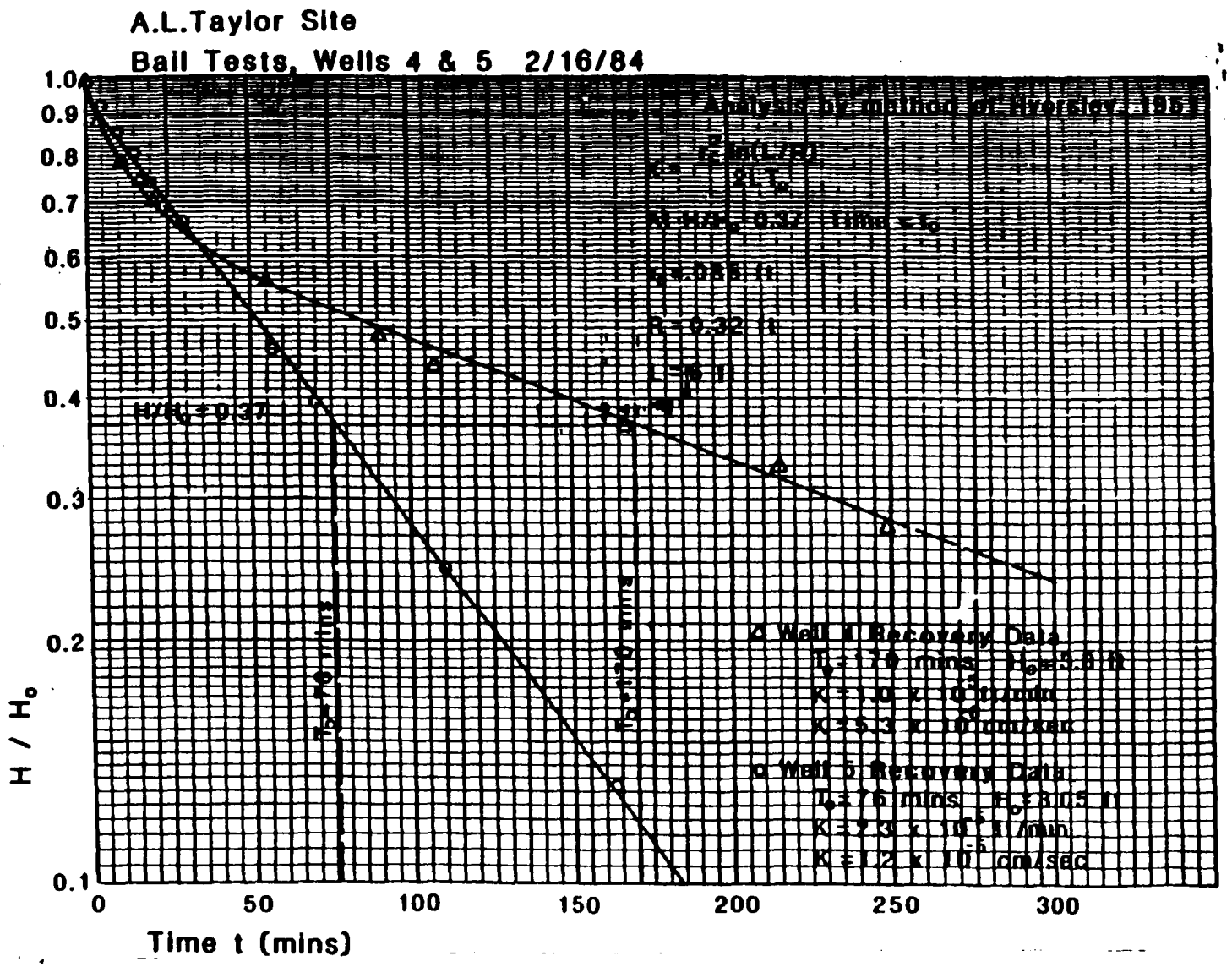

Figure 6. Recovery Curves from Bail Tests on Wells 4 and 5. Analysis from Hvorslev (1951).

strong odor, and a layer of insoluble brown organic liquid could be seen floating on the water surface. For this reason, a separate bailer was used to sample Well 4 to avoid cross contamination. Wells 1, 3, 5 and the "Field Blank" were all obtained using a single bailer, thoroughly cleaned between wells. In addition, a sealed sample blank accompanied the samples through all field procedures. Water was poured from the bailer with minimum areation into clean 40 ml glass vials with teflon lined septum caps. Vials were filled completely and capped to exclude air. Labeled vials were placed in separate plastic zip-lock bags and placed in a cooler with ice. Duplicate water samples were taken from each well. Samples from Well 3 and Well 5 were clear, while water from Well 1 was slightly turbid. The sample from Well 4 contained the same brown liquid described previously, but was otherwise clear. This was the only sample having a noticable odor. Ground water samples were delivered to Environmental Consultants Lab less than 8 hours after the first sample was taken. Chain of custody was tranferred to Mr. Robert Fuchs at that time. Field water quality measurements made on the same date are listed in Table 4. Based on conductivity, shallow ground water samples are suprisingly brackish whereas samples from the treatment pond and Wilson Creek are relatively fresh.

TABLE 4

Field Water Quality Measurements

Site	Conductivity (mhos)		Temp. (°C)	pH
Well 1	4580	@	11.0°	7.10
Well 3	2350	@	7.8°	6.45
Well 4	2600	@	9.5°	6.70
Well 5	5400	@	7.5°	6.65
Pond*	435	@	13.8°	-
Wilson Cr.**	160	@	9.5°	-

* EPA treatment pond. Sample taken at discharge point where levee is breached, approximately midway between Well 3 and Well 4.

**Sample taken about 10 feet upstream (southeast) of Well 5.

Analyses for volatile organic compounds were performed using Gas Chromatography/Mass Spectrometry Methods 5020 and 8240 (EPA, SW-846). The five "target" compounds determined were chloroethane, dichloroethane, dichloroethene (dichloroethylene), toluene, and ethyl benzene. Results of analysis are shown

in Table 5. Only the sample from Well 4 contained any of the target volatile organic compounds. This sample contained high concentrations of toluene and ethyl benzene.

A single sample taken February 16, 1984 from Well 5 was analyzed by Geosciences Research Associates, for several dissolved inorganic ions. The high field conductivity measured for ground water from this well raised the question of whether the high salinity was a natural characteristic or whether leachate contamination had occurred. The following concentrations were measured:

Sample	Hardness (t) mg/L as $CaCO_3$	Alkalinity (t) mg/L as $CaCO_3$	Sulfate (mg/L)	Chloride (mg/L)
Well 5	2580	248	400	390

The high hardness (calcium + magnesium) and the high sulfate concentration suggest that the ground water is naturally brackish as a result of dissolution of gypsum ($CaSO_4 \cdot 2\ H_2O$). This is supported by the recognition of gypsum veins and stringers in outcrops and boring samples on site (see Boring 2 test Log, Appendix). Contamination by leachate would be expected to produce higher chloride and alkalinity values than those observed.

Results

This study was designed to provide a quantitative hydrologic evaluation of the A.L. Taylor Site, and specfically to make the evaluations as outlined in the introduction.

1) Determine the permeability in the overburden/weathered shale zone between the disposal pits and Wilson Creek.

As defined by this report the overburden weathered shale zone consists of the following components. A sequence of silty clay loam and silty clay alluvial and colluvial materials that include a persistent ironstone and concretion zone in the basal part occurs in the valley of Wilson Creek. The alluvial/colluvial materials are probably continuous with loess and colluvial materials on upland and toe slope areas of the site. The unit extends from the ground surface to a depth of about 10 feet. Underlying the alluvial/colluvial materials and continuous over the entire area is a greenish silty clay soil material that is residual in origin and derived from in situ weathering of the New Providence Shale. This zone was up to 9 feet thick as observed in Boring 3. Beneath the silty clay is a zone of laminated highly weathered clay shale

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TABLE 5

RESULTS OF VOLATILE ORGANIC ANALYSIS (VOA)
FOR GROUND WATER AND SOIL SAMPLES

BORING	SAMPLE	TYPE	CHLOROETHANE	DICHLOROETHENE	DICHLOROETHANE	TOLUENE	ETHYL BENZENE
–	FIELD BLANK*	WATER	N.D.	N.D.	N.D.	N.D.	N.D.
WELL 1	1W	WATER	N.D.	N.D.	N.D.	N.D.	N.D.
WELL 3	3W	WATER	N.D.	N.D.	N.D.	N.D.	N.D.
WELL 4	4W	WATER	N.D.	N.D.	N.D.	52.9 mg/L	56.5 mg/L
WELL 5	5W	WATER	N.D.	N.D.	N.D.	N.D.	N.D.
WELL 2	2V1	SOIL	N.D.	N.D.	N.D.	N.D.	N.D.
WELL 2	2V2	SOIL	N.D.	N.D.	N.D.	N.D.	N.D.
BORING 6	6V1	SOIL	N.D.	N.D.	N.D.	N.D.	N.D.

N.D. None detected. Detection limits: 0.05 mg/L (Water)
0.05 mg/Kg (Soil)

Analyses performed by Environmental Consultants, Inc., Clarksville, Indaina, on February 24 and 27, 1984, using gas chromatography/mass spectrometry methods 5020 and 8240 from SW 846.

*FIELD BLANK consists of deionized, organic-free water collected from capped section of PVC pipe using teflon bailer in a manner identical to collection of well water samples.

Properties of Organic Compounds

Compound	Formula	Density** (g/ml)	Solubility** in Water	Boiling Pt.** (°C)
Chloroethane	H_3CCH_2Cl	0.90	slightly	12.3
Dichloroethane	ClHCCHCl	1.28	slightly	60.3
Dichloroethane	ClH_2CCH_2Cl	1.24	slightly	83.5
Toluene	$C_6H_5CH_3$	0.87	insoluble	110.6
Ethyl Benzene	$C_6H_5H_2CCH_3$	0.87	insoluble	136.2

** Source: Handbook of Chemistry and Physics, 54th Edition.

that is gradational between the silty clay and underlying, relatively unweathered shale bedrock. The lower limit of the weathered shale zone roughly corresponds to the lower limit of drive sampling. This zone is at least 2 feet thick but in places probably approaches 10 feet in thickness.

Both laboratory and in situ permeability data were gathered during this study. Lab permeability data are indicative of saturated hydrualic conductivity in the vertical direction. Four laboratory permeability measurements were made on alluvial/colluvial materials in the area east of the existing diversion ditch (Samples 3K1, 4K1, 4K2, and 5K1). The samples fell within the relatively narrow range of 1.3×10^{-7} to 7.0×10^{-7} cm/sec, which are indicative of tight impermeable soil materials. Sample 2K1 is from what are most probably colluvial materials mantling the toe slope area west of Wilson Creek. The 4.5×10^{-7} cm/sec permeability obtained from this sample is in agreement with the other alluvial/colluvial samples. Two laboratory permeability determinations were made on the residual silty clay materials (Samples 1K1 and 5K2). Results of 1.7×10^{-8} and 4.5×10^{-7} cm/sec were obtained for these samples. One sample of weathered shale was analyzed (Sample 2K2), and a hydrualic conductivity of 2.0×10^{-7} cm/sec was obtained. One permeability determination was made on largely unweathered shale. The sample was obtained by air coring procedures and resulted in a permeability of 6.3×10^{-8} cm/sec.

All laboratory measurements of the overburden and weathered shale materials indicate very low vertical hydrualic conductivity values that are in the range of those generally required for hazardous waste disposal sites. The results are in agreement with previous laboratory permeability values on shallow soil materials reported by Ecology and Environment (1982, Table 4-2).

Single-well pump and bail tests were used to evaluate field hydraulic conductivity. Well 4 was completed in the basal portion of the alluvial/colluvial materials and a hydraulic conductivity of 1.8×10^{-6} cm/sec was calculated for this material using the interpretation methods of Cooper and others, 1967. A somewhat higher hydraulic conductivity of 5.3×10^{-6} cm/sec is obtained by the interpretation methods of Hvorslev (1951). The field values are considered to be in good agreement, but are about an order of magnitude higher than those derived from the laboratory analysis. The field derived values are probably more indicative of the actual hydraulic conductivity that is relevent to contaminant migration for the following reasons. First, the field conductivity values are related to conductivity in the horizontal rather

They measure different perm
Lab = vertical
in situ = hori

than vertical direction and are more applicable to lateral contaminant transport. Second, the hydraulic conductivity of geologic materials in the vertical direction may be substantially less than that in the horizontal direction. Third, the field hydraulic conductivity determinations involve a much larger "sample" than the small sample volume used in the laboratory apparatus, and for that reason are inherently more valid types of measurements. if a sam is repres the size d not matt

Well 3 and 5 were completed in the lower portion of the residual silty clay and upper part of the weathered shale. Well 3 yielded enough water for a "mini-rate" pumping test, and a hydraulic conductivity of 3.3×10^{-5} cm/sec was calculated for this well using the interpretation methods of Papadopaulos and Cooper, 1967). Well 5 did not yield enough water for a pump test, and the results of a bail test indicated a hydraulic conductivity of 9.1×10^{-6} cm/sec, which was comparable to the hydraulic conductivity derived by the Hvorslev (1951) method.

The soil materials between the disposal pits and Wilson Creek are characterized by horizontal hydraulic conductivity in the mid 10^{-5} to low 10^{-6} cm/sec range. By comparison of field and laboratory test results, vertical hydraulic conductivity is considerably less and is generally in the 10^{-7} cm/sec range.

2) Determine the horizontal extent of contaminant migration between the disposal pits and Wilson Creek.

The results of the volatile organics analysis of well water samples indicate the weathered shale zone is largely uncontaminated east of the existing diversion ditch. None of the 5 target volatile organic compounds were detected in water samples from Wells 3 and 5. The results from Well 5 are particularly noteworthy because a considerable amount of contamination was observed on the land surface surrounding Well 5, and shallow samples of the alluvial and colluvial materials bore a strong solvent odor. As was the purpose of the surface casing and bentonite seal, contamination from the upper soil zones was eliminated and the results indicate that the weathered shale is uncontaminated east of the diversion. These results are consistent with results obtained by U.S. EPA (1979) from their borings CC-1 and CC-6.

Hole CC-6 was drilled in the approximate location of Well 5, and soil samples from 10-12 (9-11?) feet and 16-18 (14-16?) feet were found to be free of organic contamination. A shallow soil sample (4-6 feet) probably from the alluvial and colluvial materials was found to contain "12 priority organic compounds at trace (less than 5 μg/g) to 7.9 μg/g" levels. Samples from CC-1 ? It wx be nice to know what we are dealing with.

at 4-6 feet, 10-12 feet, and 16-18 feet were all "relatively free of organic and metal contamination." (The 10-12 foot and 16-18 foot samples probably correspond to the weathered shale and residual silty clay materials) are at these log locations?

Well 3, completed in the weathered shale and residual silty clay materials was free of the 5 target volatile compounds. No odor was detected to any of the samples from this boring. Well 4 was completed in the upper alluvial/colluvial materials. High levels of toluene (52.9 mg/l) and ethyl benzene (56.5 mg/l) were found in this well. An oily light solvent layer was observed in samples bailed from this well. The high concentrations probably reflect the presence of this layer of light insoluble organic compounds. West of the diversion ditch, none of the target organic compounds were detected in Well 1, even though this well was completed through at least 3 feet of landfill trash.

In summary, none of the 3 samples from the weathered shale and residual silty clay zone (Wells 1, 3 and 5) contained any detectable concentration of the 5 target volatile organic compounds. Clearly, the weathered shale and residual silty clay zones are not acting as an avenue for lateral ground water transport of contaminants east of the existing diversion ditch. Although, high levels of contaminants occur in soil and water in the upper alluvial/colluvial materials, these contaminants do not appear to exist at depth in the residual silty clay and weathered shale. This observation is difficult to explain by any type of lateral contaminant migration mechanism involving the weathered shale and residual silty clay materials in light of the comparable hydraulic conductivity between these materials and the alluvial/colluvial unit. The lack of contaminants in the weathered shale at Well 1 is particularly damaging to the lateral ground water transport idea. why? There has been no statement of GW flow directions, velocity. Needs more explanation

? may not have reached depth yet

* Contaminants in the alluvial/colluvial zone do not appear to have moved east of the Wilson Creek channel. A soil sample from Boring 6 on the east side of Wilson Creek taken from the ironstone and concretion zone was free of the target volatile compounds. Further, subsurface soil contamination is not evident north of an old surface drainage channel passing about 30 feet south of Well 2 (Figure 1). Samples of colluvial material and weathered shale from this boring were free of the target volatile organic compounds.

3) Determine ground water flow direction and flow velocity of ground water on site and downgradient of the site.

wouldn't expect it - the contamination is shallow + Ck may act as a boundry - this should be discussed

Ground water flow direction and flow velocity are dependent on hydraulic conductivity and gradient. An appropriate value for hydraulic conductivity of the alluvial/colluvial materials based on bail test results from Well 4 is 1.8×10^{-6} cm/sec. Hydraulic gradient may be estimated from the relative elevations of water level in Wells 1, 3, 4, and 5. Based on static water level measured on February 15-16, 1984 the ~~ground~~ water table beneath Wilson Creek valley was only 2 to 3 beneath the surface and a slight northward gradient is apparent (Figure 2). The consistent water levels between Wells 3, 4, and 5 establish hydrologic continuity between the alluvial/colluvial materials, residual silty clay, and the weathered shale. The static water level in Well 1 was below that of Well 4, and would seem to indicate that the level in Well 1 had not yet reached equilibrium on February 16. It was noted that the water level in Well 1 had risen progressively between observations on February 3 (dry), February 7 (11.9') and February 16 (8.85'). As indicated by the bail test results, the weathered shale zone at Well 1 is very impermeable. Water contained in the waste material at Well 1 is probably perched on the impermeable weathered shale which accounts for the leachate seeps on the west side of the diversion ditch observed prior to and during this study (Figure 3). It is also noted that the water level in the diversion ditch was 2.4 to 6.3 feet above the static water wells in Wells 3, 4 and 5, and in fact was above the surface of the Wilson Creek valley. What have previously been identified as leachate seeps along the east side of the levee adjacent to Well 4 are probably indicative of a seepage surface through the levee induced by the water level in the diversion ditch.

For the purposes of calculating a ground water flow rate toward the Wilson Creek valley, a static water level of 535 feet ASL will be assumed in Well 1. The ground water flow velocity is given by a straight forward application of Darcy's Law.

$$v = -K \frac{dh}{dl} = -1.8 \times 10^{-6} \text{ cm/sec} \times \frac{-3.1 \text{ ft}}{103 \text{ ft}}$$

$$= 5.42 \times 10^{-8} \text{ cm/sec}$$

$$= 1.71 \text{ cm/yr.}$$

Similarily, ground water flow rates northward along Wilson Creek may be estimated from the gradient between Wells 3 and 5.

$$v = -K \frac{dh}{dl} = -1.8 \times 10^{-6} \times \frac{-3.9}{277} \text{ ft}$$

$$= 2.53 \times 10^{-8} \text{ cm/sec}$$

$$= 0.80 \text{ cm/yr.}$$

Clearly, these ground water flow rates indicate a very slow ground water movement and an insignificant rate of contaminate release off site by ground water flow.

Conclusions

Given such very low ground water flow rates, a mechanism is needed to explain the occurrence of contaminated soil materials in the location of Wells 4 and 5 and contaminated ground water from Well 4. These contaminants could not possibly have been transported by saturated ground water flow from the nearest known disposal cell (approximately 90' west of Well 4) in the time period since their disposal, given the above calculated ground water flow rates.

The existence of toluene and ethyl benzene in Well 4 at a possible depth of 10.5 feet below the ground surface requires a contaminant transport mechanism other than saturated ground water flow. Lab permeameter tests have shown that vertical saturated permeabilities of the soil materials are quite low. In reality, infiltrating fluids must first pass through unsaturated soil near the ground surface. Permeability values for unsaturated materials are not so well defined and are difficult to measure. However, vertical flow through the unsaturated zone may be considerably faster than rates indicated by laboratory permeability measurements of saturated soil materials. Contaminants may move realtively freely through the unsaturated zone to the top of the water table. The downward movement of compounds such as toluene and ethyl benzene which are insoluble and have densities less than water (about 0.87 g/ml) would be limited by the top of the saturated zone. These compounds would tend to remain at the top of the saturated zone. This would explain the fact that contaminants were detected in the shallow soil materials at Well 5, but were not detected in water samples from this well. Well 5 was screened in the weathered shale zone, well below the water table.

The data collected during this study suggest that the area of contaminated soil and ground water is limited to, and it is believed controlled by, the area of known surface contamination. The area of surface contamination is

controlled by the drainage pattern that existed during operation of the landfill. The surface may be contaminated by direct spill of liquid waste, or by surface water transport of these wastes by overland or channelized flow. It is suggested from the data presented here that Wilson Creek and another small channel draining the north side of the site (Figure 1) effectively intercepted overland and channelized flow off the site and effectively limited the area of contamination to the landfill side of the drainageways.

Overland flow of contaminants in surface water runoff may infiltrate into the shallow soil layers and thereby contaminate soil material down to the level of the water table. The presence of contaminated soil and water down to a possible depth of about 10 feet in the base of the alluvial and colluvial materials in Well 4 may be related to the depth of the seasonal low water table which would be expected to fluctuate in response to seasonally related transpiration of ground water and soil moisture in the valley of Wilson Creek.

Numerous dead trees, presumedly killed by contamination from the site occur along the west side of Wilson Creek channel, however very few dead trees occur east of the channel. The distribution of dead trees suggests that Wilson Creek effectively limited the eastward overland flow of contaminants from the site. This observation is consistent with analytical results showing highly contaminated soil in Well 4 shallow materials west of Wilson Creek, and the absence of contamination in sample 6V1 from Boring 6 east of the creek. Similarly, no contamination was found in soil material in Boring 2 north of the drainageway along the north end of the site.

In conclusion, it would appear that the soil materials on and adjacent to the Taylor Site are sufficiently impermeable to restrict contaminant release, via lateral ground water flow, to an insignificant rate. The observed pattern of soil and ground water contamination is consistent with contaminant migration via overland and channelized surface flow and infiltration and unsaturated flow is insignificant, and under the remedial action design proposed by TenEch (1983) the release of contaminants by surface water flow would be negated by the proposed clay and vegetative cover.

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Appendix

Drilling Logs

Analytical Data

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

TELEPHONE MEMORANDUM

USEPA - Region IV
ARCS-Site Assessment
Preliminary Assessment
Clark's Landfill
Louisville Water Company Service Info.

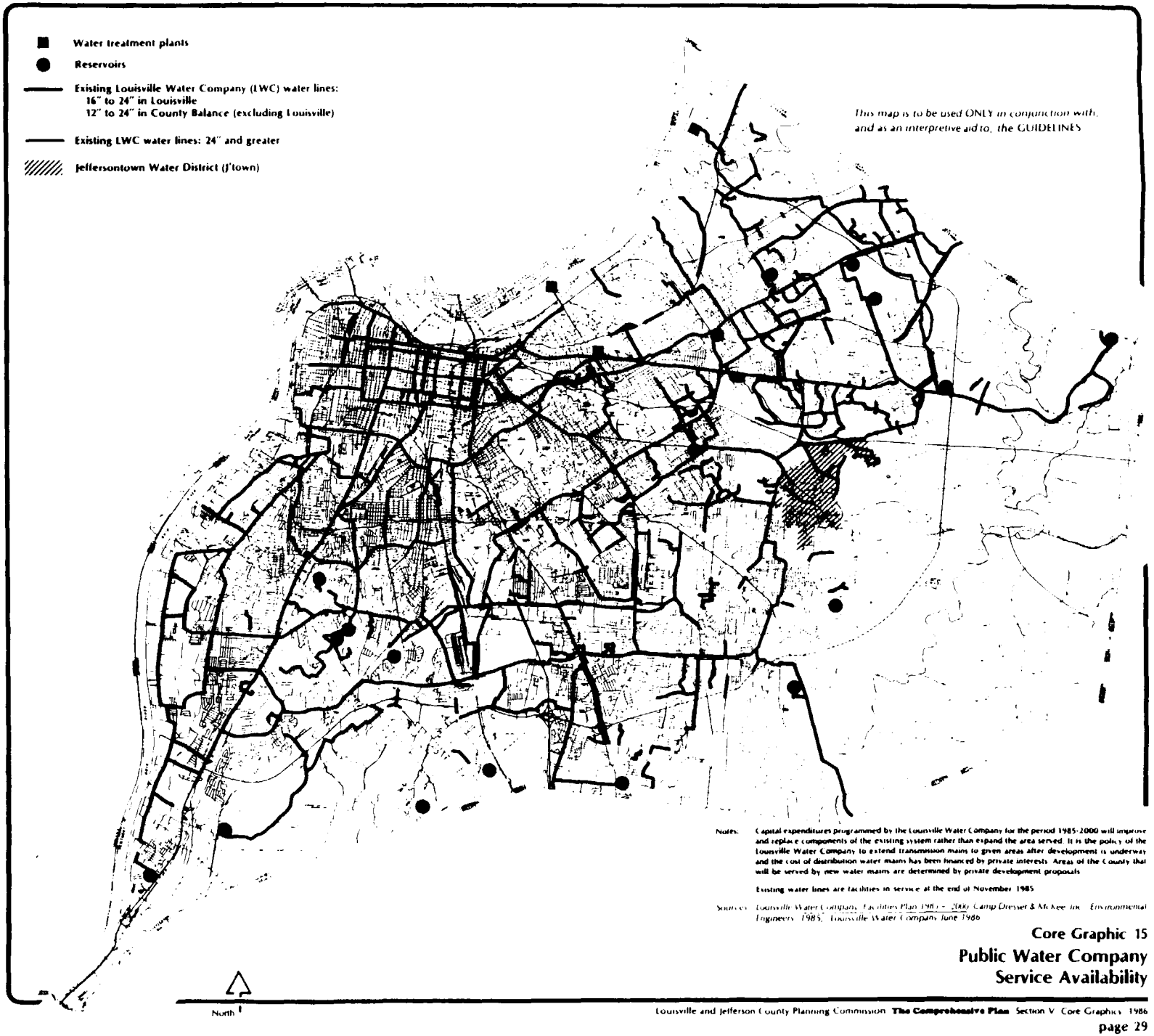
BVWST Project 52009.032
BVWST File 52009.032
March 25, 1993
10:00 a.m.

To:	Steve Hubbs, Engineer
Company:	Louisville Water Company
Phone No.:	502-569-3675

Recorded by: Dane G. Pehrman

Called to find out service range and sources of water for the Louisville Water Company (LWC) System. Mr. Hubbs informed me that the only water service in Jefferson County is the LWC System. Any resident not on the LWC system draws water from individual wells into the alluvial aquifer.

The water service range is as described on the attached map of the LWC System. This system is supplied by two surface water intakes located in northern Jefferson County on the Ohio River. A surface water intake, located on Zorn Avenue, draws approximately 1 million gallons per day (GPD) from the river. A second surface water intake, located just east of Herrods Creek, draws approximately 20 million GPD from the Ohio. The system is not currently served by any groundwater wells, however, the LWC plans to begin pumping 1,000,000 to 2,000,000 gallons per day from a alluvial aquifer well screened at 70 to 100 feet below land surface. This groundwater well is located on Zorn Avenue in northern Louisville.



Notes: Capital expenditures programmed by the Louisville Water Company for the period 1985-2000 will improve and replace components of the existing system rather than expand the area served. It is the policy of the Louisville Water Company to extend transmission mains to given areas after development is underway and the cost of distribution water mains has been financed by private interests. Areas of the County that will be served by new water mains are determined by private development proposals.

Existing water lines are facilities in service at the end of November 1985.

Sources: *Louisville Water Company, Facilities Plan 1985 - 2000*, Camp Dresser & McKee Inc. Environmental Engineers, 1985; Louisville Water Company, June 1986.

Core Graphic 15

Public Water Company Service Availability

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

Reference 23

TELEPHONE MEMORANDUM

USEPA Region IV
ARCS-Site Assessment
Bethel Church Burn Site
Salt River Water District service area

BVWST Project 52009.028
BVWST File 52009.028
March 31, 1993
1:30 p.m.

To: Jim Rice
Company: Salt River Water District
Phone No.: 1-502-955-9281

Recorded by: Bruce N. Harrison BNH

Asked Mr. Rice about their supply source and the location of any surface water intakes. He stated that SRWD does not have any intakes or treatment facilities since they purchase their water from Louisville Water Company (LWC). He also stated that all of the smaller water companies in the area purchase their water from LWC.

Mr. Rice said that the SRWD extends from east of I-65, southward to Route 480, south to Route 61. He also stated that the service extends east toward Mount Washington, ending at the Floyds Fork bridge.

Mr. Rice started that the SRWD and the Kentucky Turnpike Water District will be merging in 30 days.

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

TELEPHONE MEMORANDUM

USEPA - Region IV
ARCS-Site Assessment
Preliminary Assessment
Clark's Landfill
Extent of Kentucky Tnpk. Water Dist. System

BVWST Project 52009.032
BVWST File 52009.032
March 25, 1993
1:45 p.m.

To: John Sadoris
Company: Sadoris and Associates
Phone No.: 1-502-955-6018

Recorded by: Dane G. Pehrman

Spoke with Mr. Sadoris to determine if the Kentucky Turnpike Water District (KYWD) services any areas within the four mile radius of the Clark's Landfill site. Sadoris and Associates is the consulting engineering firm retained by the Kentucky Turnpike to design and administer the system.

Mr. Sadoris explained that the KYWD supplies areas in northern Bullitt County with water purchased from the Louisville Water Company. I asked if the KYWD supplied water to residents along Knob Creek Road or in this general area. Mr. Sadoris stated there are no water mains to this area of the county; all residents in this area are supplied by private wells.

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

Reference 25

TELEPHONE MEMORANDUM

USEPA - Region IV
ARCS-Site Assessment
Bethel Church Burn Site
Shepherdsville Water Company
Distribution Area and Source

BVWST Project 52009.028
BVWST File 52009.028
March 25, 1993
2:00 p.m.

To:	Buddy McCovens, Supervisor
Company:	Shepherdsville Water Company
Phone No.:	1-502-955-7803

Recorded by: Bruce N. Harrison

Mr. McCovens stated that Shepherdsville purchases their water from the Louisville Water Company (LWC). He stated that the Shepherdsville system only serves the city of Shepherdsville; all areas outside the city are served by the Salt River Water District or the Kentucky Turnpike Water District.

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

TELEPHONE MEMORANDUM

USEPA - Region IV
ARCS-Site Assessment
Preliminary Assessment
Clark's Landfill
West Point Water System

BVWST Project 52009.032
BVWST File 52009.032
March 25, 1993
4:10 p.m.

To:	Vernon Curl
Company:	West Point Water Works
Phone No.:	1-502-922-4260

Recorded by: Dane G. Pehrman

Spoke with Mr. Curl to determine the area covered by the West Point system and how the system is supplied.

Mr. Curl stated that the system only serves the town of West Point and does not serve any areas north of Salt River. The system is supplied by two groundwater wells on 6th Street in West Point. There are no surface water intakes on the Ohio River for this system.

Reference 27

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

TELEPHONE MEMORANDUM

USEPA - Region IV
ARCS-Site Assessment
Preliminary Assessment
Clark's Landfill Site
Extent of Fort Knox Water System

BVWST Project 52009.032
BVWST File 52009.032
March 25, 1993
11:00 a.m.

To:	Bob Ender
Company:	Fort Knox Water Department
Phone No.:	1-502-624-5252

Recorded by: Dane G. Pehrman

Spoke with Mr. Ender to determine if the Fort Knox system serviced and areas off the base limits or north of the Salt River.

Mr. Ender stated that the Fort Knox system is a groundwater supplied system and does not cover any areas north of the Salt River.

Reference 28

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

TELEPHONE MEMORANDUM

USEPA - Region IV
ARCS-Site Assessment
Preliminary Assessment
Clark's Landfill Site
Depth of Wells in Northwestern Bullitt Co.

BVWST Project 52009.032
BVWST File 52009.032
March 26, 1993
3:45 p.m.

To:	Mary Ann Blanton, Inspector
Company:	Bullitt County Health Department
Phone No.:	1-502-543-2415

Recorded by: Dane G. Pehrman

Spoke with Ms. Blanton regarding the source of drinking water to residents in the northwestern Bullitt County Area. Ms. Blanton informed me that there are no public water supplies west of Shepardsville. Residents in the northwestern Bullitt County area receive water from private wells or cisterns. She stated that most people use wells screened at a depth of 60 to 100 feet since the cost of filling cisterns is prohibitive.

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

TELEPHONE MEMORANDUM

USEPA - Region IV
ARCS-Site Assessment
Preliminary Assessment
Clarks Landfill Site
Groundwater Users in LWC Coverage Area

BVWST Project 52009.032
BVWST File 52009.032
March 25, 1993
10:15 a.m.

To: Alan Arbuckle, Engineer
Company: Louisville Water Company
Phone No.: 1-502-569-3609

Recorded by: Dane G. Pehrman

Spoke with Mr. Arbuckle regarding residents within the coverage area of the Louisville Water Company (LWC) system who are still using their own private wells. Mr. Arbuckle performed a study in 1980 identifying residents within the LWC system range that did still used private potable wells.

Mr. Arbuckle identified the following areas in the 4 mile radius of the Clark's Landfill Site that were not on LWC water:

- 3 homes on Chisolm Road,
- 23 homes on W. Fincastle Road,
- 7 homes on E. Fincastle Road, and
- 5 homes on Scenic Drive.

These areas were marked as described to me on the four-mile radius map showing water service in the site area.

Mr. Arbuckle confirmed that these private wells are usually less than 100 feet and draw from the alluvial aquifer.

BASTE SCIENCE AND TECHNOLOGY CORP.

Owner USEPA RE
Plant JEFF. FOR
Project No 52009.049 File No
Title POPULATION CALCULATION WITHIN 4-MILE RADIUS TARGET AREA

Computed By J.P. NETT
Date 9/29 19 93
Checked By
Date 19
Page 1 of 3

DO NOT WRITE IN THIS SPACE

SCOPE TO DETMINE THE HUMAN POPULATION WITHIN A 4-MILE RADIUS OF THE JEFFERSON FOREST DRUM SITE

REFERENCES
1. U.S.G.S. 7.5-MINUTE SERIES TOPOGRAPHIC QUADRANGLE MAPS OF KENTUCKY: LOUISVILLE EAST, 1982 (PHOTOREV. 1987); LOUISVILLE WEST, 1983 (PHOTOREV. 1987); VALLEY STATION, 1982 (PHOTOREV. 1987); BROOKS, 1981 (PHOTOREV. 1987
2. U.S EPA GRAPHICAL EXPOSURE MODELLING SYSTEM (GEMS) DATABASE PRINT OUT FOR POPULATION WITHIN A 4-MILE RADIUS OF THE JEFFERSON FOREST DRUM SITE, LAT 38°5'5.6" N, LONG. 85°43'37" W, 1983 CENSUS DATA
3. 1990 CENSUS OF POPULATION, GENERAL POPULATION CHARACTERISTICS, KENTUCKY, TABLE 2 - SUMMARY OF GENERAL CHARACTERISTICS OF HOUSEHOLDS AND FAMILIES: 1990, ISSUED JUNE 1992.

PROCEDURE THE 4-MILE TARGET AREA IS SUBDIVIDED INTO CONCENTRIC RINGS OF 1/4-MI, 1/2-MI, 1-MI, 2-MI, AND 3-MI RADII. THE TARGET AREA IS FURTHER DIVIDED INTO 8 EQUAL SEGMENTS COMMON TO THE FOCUS OF THE 4-MILE TARGET CIRCLE. POPULATIONS IN SEGMENTS CHARACTERIZED BY HIGH-DENSITY POPULATION (PINK SHADING ON QUAD) ARE DETERMINED FROM GEMS DATA. POPULATIONS IN THE REMAINING SEGMENTS ARE DETERMINED BY A HOUSE COUNT X THE AVE. HOUSEHOLD POP.

WASTE SCIENCE AND TECHNOLOGY CORP.

Owner USEPA REGION IV
Plant JEFF. FOREST DRUM Unit
Project No 52009.049 File No
Title POPULATION CALCULATION WITHIN 4-MILE RADIUS TARGET AREA

Computed By J. P. NETT
Date 9/29 19 93
Checked By
Date 19
Page 2 of 3

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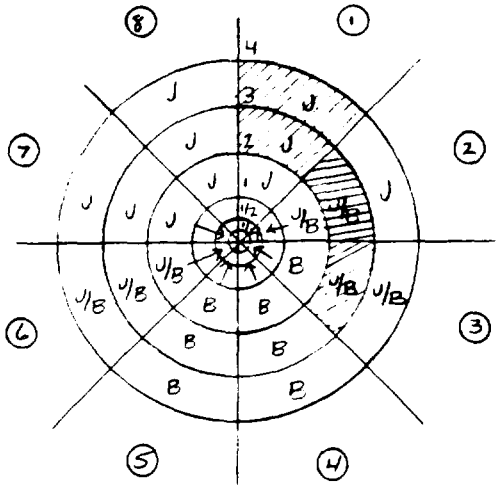
NOTE
CENTER OF TARGET AREA AT SW CORNER OF SITE BOUNDARY



LEGEND

GEMS DATA
B - BULLITT CO
J - JEFFERSON CO
J/B - BOTH COS.

HOUSE COUNT * (FROM REF. 1)

DIST. \ SGMT.	1	2	3	4	5	6	7	8	TOTAL
0-1/4	J-0	J-1 B-2	B-1	B-0	B-0	J-0 B-0	J-0	J-0	4
1/4-1/2	J-0	J-0 B-0	B-13	B-4	B-2	J-0 B-0	J-0	J-0	19
1/2-1	J-1	J-8 B-15	B-29	B-49	B-7	J-0 B-0	J-47	J-88	244
1-2	J-76	J-332 B-43	B-253	B-208	B-84	J-18 B-7	J-344	J-239	1604
2-3	GEMS	GEMS	GEMS	B-270	B-34	J-49 B-3	J-579	J-324	1,259 *
3-4	GEMS	J-746	J-2 B-259	B-335	B-178	J-39 B-34	J-411	J-486	2,490 *

* EXCLUDING GEMS DATA

WASTE SCIENCE AND TECHNOLOGY CORP.

Owner USEPA REGION IV
Plant JEFF. FOREST DRUM Unit
Project No 52009.049 File No
Title POPULATION CALCULATION WITHIN 4-MILE RADIUS TARGET AREA

Computed By J. P. NETT
Date 9/29 19 93
Checked By
Date 19
Page 3 of 3

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POPULATION CALCULATION

(FROM REF. 3)

AVE. PERSONS PER HOUSE HOLD -
JEFFERSON CO. = 2.48
EULLITT CO. = 2.97

DIST. \ SECT.	1	2	3	4	5	6	7	8	TOTAL
0-1/4	0	2.5 5.9	3	0	0	0 0	0	0	11
1/4-1/2	0	0 0	38.6	11.9	5.9	0 0	0	0	56
1/2-1	2.5	19.8 44.6	86.1	145.5	20.8	0 0	116.6	218.2	654
1-2	188.5	823.4 127.7	751.4	617.8	249.5	44.6 20.8	853.1	592.7	4,270
2-3	3997	6609	5549	801.9	101	121.5 8.9	1435.9	803.5	19,428
3-4	569	1850.1	5 769.2	995	528.7	96.7 101	1019.3	1205.3	7,139

4-MI RADIUS TARGET AREA TOT. - 31,558

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED.

OVERSIZED

DOCUMENT

Jefferson Forest Drum Site
LATITUDE 38: 5: 6 LONGITUDE 85:43:37 1983 POPULATION

KM	0.00-.400	.400-.810	.810-1.60	1.60-3.20	3.20-4.80	4.80-6.40	SECTOR TOTALS
S 1	0	0	0	0	3997	569	4566
S 2	0	0	0	0	6609	7296	13905
S 3	0	0	0	251	5549	1229	7029
S 4	0	0	0	0	5679	0	5679
S 5	0	0	0	0	0	5491	5491
S 6	0	0	0	0	0	1434	1434
S 7	0	0	0	0	0	3583	3583
S 8	0	0	2178	1608	3978	3319	11083
RING TOTALS	0	0	2178	1859	25812	22921	52770

Reference 31

Reference 32

U.S. Departmen
Economics and S
BUREAU OF THE

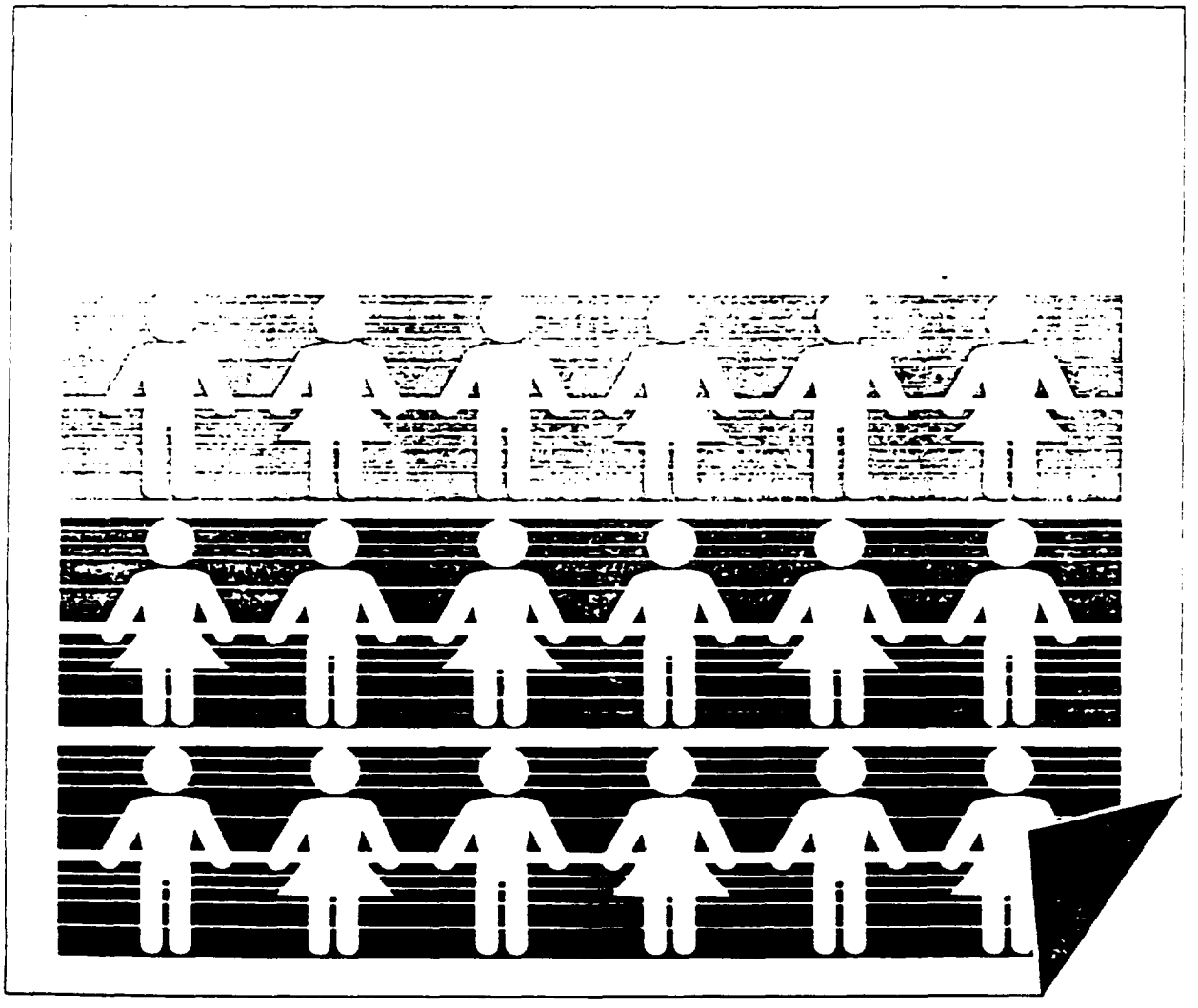
CENSUS '90

1990 CP-1-19

1990 Census of Population

General Population Characteristics

Kentucky



1990 CP-1-19

1990 Census of Population

General Population Characteristics

Kentucky

Issued June 1992

U.S. Department of Commerce
Barbara Hackman Franklin, Secretary
Rockwell A. Schnabel, Deputy Secretary

Economics and Statistics Administration
Mark W. Plant, Acting Under Secretary
for Economic Affairs and Administrator

BUREAU OF THE CENSUS
Barbara Everitt Bryant, Director

Table 2. **Summary of General Characteristics of Households and Families: 1990**

[For definitions of terms and meanings of symbols, see text]

State Urban and Rural and Size of Place Inside and Outside Metropolitan Area County Place and [In Selected States] County Subdivision [1,000 or More Persons]	All households	Percent of all households											Persons per —	
		Family households						Nonfamily households						
				Married-couple family		Female householder, no husband present			Householder living alone					
											65 years and over			
		Total	With own children under 18 years	Total	With own children under 18 years	Total	With own children under 18 years	Total	Total	Female	Total	Female	Householder 65 years and over	Household	Family
The State	1 379 782	73.6	36.1	59.2	28.3	11.6	6.5	26.4	23.3	14.5	10.3	8.2	22.6	2.60	3.08
URBAN AND RURAL AND SIZE OF PLACE															
Urban	741 850	68.0	32.7	51.5	23.5	13.7	8.0	32.0	27.8	17.8	11.5	9.5	23.1	2.46	3.03
Inside urbanized area	497 149	67.9	32.6	51.5	23.6	13.5	7.8	32.1	27.3	16.9	10.2	8.3	21.2	2.49	3.06
Central place	242 611	62.1	28.6	43.8	18.6	15.3	8.8	37.9	32.1	19.7	11.8	9.6	23.1	2.34	2.99
Urban fringe	254 538	73.5	36.5	58.9	28.4	11.8	6.8	26.5	22.8	14.2	8.7	7.1	19.4	2.63	3.1[illegible]
Outside urbanized area	244 701	68.1	32.9	51.4	23.2	14.2	8.5	31.9	28.7	19.7	14.2	11.9	27.0	2.41	2.97
Place of 10,000 or more	121 753	67.4	33.3	51.0	23.7	13.9	8.5	32.6	28.4	18.7	12.6	10.5	24.1	2.42	2.99
Place of 2,500 to 9,999	122 948	68.8	32.4	51.8	22.8	14.4	8.5	31.2	29.0	20.6	15.8	13.2	29.9	2.40	2.96
Rural	637 932	80.2	40.1	68.2	33.9	9.1	4.8	19.8	18.0	10.6	8.8	6.7	21.9	2.75	3.13
Place of 1,000 to 2,499	50 943	71.1	34.3	54.2	25.2	14.1	7.9	28.9	27.2	19.1	15.2	12.6	29.0	2.48	3.02
Place of less than 1,000	27 545	71.8	34.0	56.9	26.4	12.1	6.5	28.2	26.5	18.2	15.9	13.0	30.7	2.50	3.03
Other rural	559 444	81.4	40.9	70.0	35.1	8.4	4.4	18.6	16.8	9.4	7.9	5.8	20.8	2.79	3.14
INSIDE AND OUTSIDE METROPOLITAN AREA															
Inside metropolitan area	651 086	70.8	34.5	55.3	26.0	12.6	7.2	29.2	25.0	15.4	9.7	7.8	20.7	2.56	3.08
In central city	256 344	62.6	28.8	44.3	18.9	15.4	8.9	37.4	31.7	19.5	11.8	9.5	23.2	2.35	2.99
Not in central city	394 742	76.1	38.1	62.5	30.7	10.8	6.2	23.9	20.7	12.7	8.3	6.6	19.2	2.69	3.13
Urban	286 205	73.5	36.6	58.5	28.3	12.1	7.0	26.5	22.9	14.5	9.1	7.4	19.8	2.62	3.11
Inside urbanized area	254 538	73.5	36.5	58.9	28.4	11.8	6.8	26.5	22.8	14.2	8.7	7.1	19.4	2.63	3.11
Outside urbanized area	31 667	73.2	37.7	55.5	27.2	14.8	9.1	26.8	23.8	16.2	11.8	9.9	23.2	2.57	3.05
Rural	108 537	83.1	42.1	72.9	37.0	7.4	3.9	16.9	14.7	8.0	6.2	4.6	17.4	2.88	3.19
Outside metropolitan area	728 696	76.2	37.6	62.7	30.4	10.6	5.9	23.8	21.7	13.7	10.9	8.5	24.2	2.63	3.07
Urban	201 632	67.2	32.1	50.8	22.6	13.9	8.3	32.8	29.6	20.3	14.7	12.3	27.7	2.38	2.96
Inside urbanized area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outside urbanized area	201 632	67.2	32.1	50.8	22.6	13.9	8.3	32.8	29.6	20.3	14.7	12.3	27.7	2.38	2.96
Place of 10,000 or more	95 019	66.1	32.5	50.3	23.2	13.4	8.2	33.9	29.4	19.3	12.8	10.7	24.3	2.39	2.97
Place of 2,500 to 9,999	106 613	68.2	31.6	51.4	22.2	14.3	8.4	31.8	29.7	21.3	16.4	13.7	30.8	2.38	2.95
Rural	527 064	79.6	39.7	67.2	33.3	9.4	5.0	20.4	18.7	11.1	9.4	7.1	22.9	2.73	3.11
COUNTY															
Adair County	5 800	76.1	34.7	63.9	28.9	9.5	4.7	23.9	22.4	14.7	13.3	10.2	28.3	2.57	3.0[illegible]
Allen County	5 595	76.3	36.4	65.5	30.4	8.6	4.8	23.7	22.1	14.2	13.0	10.0	28.0	2.59	3.02
Anderson County	5 438	77.8	38.4	66.0	32.1	9.0	4.9	22.2	20.0	12.8	10.0	8.3	22.1	2.66	3.06
Ballard County	3 191	72.8	32.7	62.8	27.1	7.6	4.3	27.2	25.2	15.7	14.5	11.7	30.1	2.44	2.9[illegible]
Barren County	13 136	75.4	34.6	63.5	28.3	9.5	5.2	24.6	23.0	15.6	12.7	10.2	26.8	2.54	2.99
Bath County	3 659	76.3	35.0	62.7	28.0	10.1	5.5	23.7	22.1	13.9	12.7	9.4	26.9	2.61	3.05
Bell County	11 512	76.4	38.6	57.1	29.1	15.6	8.1	23.6	22.0	14.2	11.5	9.1	25.5	2.69	3.1[illegible]
Boone County	20 127	78.1	42.6	65.7	35.6	9.5	5.7	21.9	18.4	11.2	7.0	5.7	15.2	2.84	3.2[illegible]
Bourbon County	7 250	75.8	36.5	60.7	28.2	12.2	7.1	24.2	21.2	14.3	11.2	9.2	24.9	2.63	3.1[illegible]
Boyd County	19 876	74.1	33.2	61.0	26.4	10.9	6.0	25.9	24.0	16.0	12.4	10.2	26.3	2.50	[illegible]
Boyle County	9 483	73.5	34.1	59.8	26.5	11.3	6.5	26.5	24.4	16.4	12.1	9.9	25.1	2.49	[illegible]
Bracken County	2 872	75.9	36.0	62.4	29.0	9.7	5.3	24.1	21.9	14.1	13.4	10.5	27.8	2.68	[illegible]
Breathitt County	5 555	78.9	41.5	61.8	32.7	13.3	7.4	21.1	19.6	11.4	9.0	6.8	21.0	2.78	[illegible]
Breckinridge County	6 159	75.7	35.7	63.7	29.6	8.8	4.6	24.3	22.8	13.3	11.9	8.6	27.0	2.63	[illegible]
Bullitt County	15 965	84.3	46.2	71.7	39.1	9.2	5.4	15.7	13.5	7.3	5.1	3.8	13.1	2.97	[illegible]
Butler County	4 180	76.7	38.3	64.6	32.4	8.6	4.4	23.3	21.4	13.3	11.3	8.6	25.7	2.64	[illegible]
Caldwell County	5 274	72.9	31.1	60.5	24.8	10.2	5.4	27.1	25.6	17.6	14.9	12.2	31.6	2.46	[illegible]
Calloway County	11 607	68.4	29.4	58.6	24.0	7.8	4.6	31.6	27.1	17.3	12.9	10.5	28.4	2.34	[illegible]
Campbell County	31 169	71.3	35.1	56.5	27.5	11.7	6.3	28.7	25.3	16.0	11.2	9.0	23.2	2.66	[illegible]
Carlisle County	2 106	73.4	31.3	62.5	26.4	8.4	3.9	26.6	25.1	16.7	15.8	12.7	33.5	2.49	[illegible]
Carroll County	3 505	72.4	36.2	57.0	27.6	12.0	6.9	27.6	24.4	14.5	11.9	9.0	25.0	2.5[illegible]	[illegible]
Carter County	8 679	79.3	39.3	65.7	32.7	10.6	5.3	20.7	19.2	11.9	10.2	7.7	24.7	2.75	[illegible]
Casey County	5 436	76.7	35.9	64.1	29.8	9.7	4.9	23.3	22.1	13.6	11.9	8.9	27.4	2.59	[illegible]
Christian County	21 636	77.0	41.6	61.5	32.6	12.9	7.8	23.0	20.6	12.4	9.2	7.2	20.1	2.73	[illegible]
Clark County	10 973	77.4	37.0	63.8	29.8	11.0	6.1	22.6	20.1	13.3	9.8	8.2	22.1	2.66	[illegible]
Clay County	7 367	82.8	45.0	66.8	36.9	12.5	6.4	17.2	16.2	9.8	7.9	6.1	21.5	2.93	[illegible]
Clinton County	3 591	74.4	34.4	60.5	27.7	10.7	5.4	25.6	24.1	15.3	12.8	9.9	26.7	2.55	[illegible]
Crittenden County	3 646	72.9	33.1	62.1	27.6	8.2	4.4	27.1	25.6	16.7	15.6	12.1	30.2	2.48	[illegible]
Cumberland County	2 714	74.2	30.8	57.5	23.9	12.7	5.6	25.8	24.0	15.4	14.0	10.6	31.5	2.47	[illegible]
Daviess County	33 036	72.6	36.3	58.5	28.2	11.5	7.0	27.4	24.8	15.6	11.0	9.0	22.6	2.56	[illegible]
Edmonson County	3 843	80.4	37.3	68.8	31.4	9.3	5.1	19.6	18.6	12.2	10.0	7.9	25.4	2.64	[illegible]
Elliott County	2 324	79.1	41.5	63.0	33.2	12.0	6.3	20.9	19.3	11.1	10.2	7.0	24.6	2.78	[illegible]
Estill County	5 357	78.1	38.3	62.2	30.2	12.9	6.9	21.9	20.5	13.8	11.7	9.6	26.3	2.71	[illegible]
Fayette County	89 529	63.0	30.3	48.3	22.1	12.2	7.3	37.0	29.1	17.1	7.8	6.4	16.2	2.38	[illegible]
Fleming County	4 626	75.9	35.9	63.5	29.8	9.0	4.5	24.1	22.6	14.2	12.6	9.6	27.6	2.62	[illegible]
Floyd County	15 644	79.2	42.8	63.9	34.8	12.1	6.6	20.8	19.5	12.2	9.2	7.3	22.0	2.76	[illegible]
Franklin County	17 385	69.5	33.6	54.9	25.4	12.0	6.9	30.5	27.0	16.8	10.1	8.2	20.8	2.44	[illegible]
Fulton County	3 378	68.6	29.8	51.4	20.5	14.5	8.2	31.4	29.4	21.2	18.5	15.8	34.8	2.42	[illegible]
Gallatin County	1 941	76.9	39.0	63.9	32.4	9.6	5.0	23.1	20.7	12.2	11.2	8.2	23.3	2.75	[illegible]
Garrard County	4 435	78.0	34.9	65.4	28.8	9.8	4.9	22.0	20.0	12.9	10.9	8.6	26.8	2.59	[illegible]
Grant County	5 585	78.7	41.0	65.8	33.2	9.5	5.9	21.3	19.5	11.9	10.0	7.8	22.0	2.78	[illegible]
Graves County	13 377	73.6	32.7	62.8	26.9	8.8	5.0	26.4	24.8	16.6	14.4	11.7	30.3	2.47	[illegible]
Grayson County	7 991	76.5	36.6	64.7	30.2	8.9	5.1	23.5	21.5	12.9	11.0	7.9	25.0	2.61	[illegible]
Green County	4 089	76.4	33.0	66.2	28.2	8.0	3.9	23.6	22.4	14.4	13.3	10.3	29.6	2.49	[illegible]
Greenup County	13 414	80.6	37.8	69.1	32.2	9.1	4.5	19.4	18.1	11.9	8.6	6.9	21.5	2.71	[illegible]
Hancock County	2 795	81.1	43.4	70.1	36.7	7.9	5.1	18.9	17.6	9.9	8.2	6.2	19.7	2.79	[illegible]
Hardin County	29 358	78.8	44.3	66.2	36.1	10.2	6.7	21.2	18.6	10.8	6.6	5.2	15.3	2.78	[illegible]
Harlan County	13 269	76.8	40.1	60.3	32.3	13.3	6.4	23.2	21.9	14.2	11.4	9.2	25.5	2.74	[illegible]
Harrison County	6 086	75.2	36.6	61.8	29.1	10.4	6.1	24.8	22.5	14.5	13.1	10.0	26.9	2.62	[illegible]
Hart County	5 740	75.5	35.3	62.6	28.9	9.9	5.1	24.5	22.8	14.8	12.7	9.8	28.0	2.58	[illegible]

Table 2. Summary of General Characteristics of Households and Families: 1990—Con.

[For definitions of terms and meanings of symbols, see text]

State / Urban and Rural and Size of Place / Inside and Outside Metropolitan Area / County / Place and [In Selected States] County Subdivision [1,000 or More Persons]	All households	Percent of all households: Family households: Total	Family households: With own children under 18 years	Married-couple family: Total	Married-couple family: With own children under 18 years	Female householder no husband present: Total	Female householder no husband present: With own children under 18 years	Nonfamily households: Total	Householder living alone: Total	Householder living alone: Female	65 years and over: Total	65 years and over: Female	Householder 65 years and over	Persons per—: Household	Family
COUNTY—Con.															
Henderson County	16 558	73.7	36.7	59.8	28.6	11.4	6.9	26.3	23.5	14.4	10.4	8.4	21.9	2.56	3.24
Henry County	4 896	75.6	35.0	61.8	27.7	9.8	5.6	24.4	21.8	13.3	11.7	9.2	25.4	2.61	3.03
Hickman County	2 188	74.5	31.2	62.0	24.7	9.7	5.5	25.5	23.8	16.0	14.4	11.4	32.5	2.47	2.93
Hopkins County	17 760	75.1	36.5	61.5	29.0	11.1	6.3	24.9	23.0	14.9	11.6	9.2	25.3	2.56	3.02
Jackson County	4 381	78.9	40.2	65.2	32.6	10.6	6.1	21.1	20.2	11.9	11.0	7.8	25.3	2.71	3.13
Jefferson County	264 138	68.0	31.5	50.5	22.0	14.5	8.2	32.0	27.5	17.0	10.5	8.4	22.4	2.48	3.24
Jessamine County	10 601	79.9	41.7	66.8	34.2	10.1	6.0	20.1	16.6	10.2	6.6	5.3	16.2	2.77	3.12
Johnson County	8 469	78.3	40.4	64.6	33.6	10.9	5.5	21.7	20.5	13.0	10.1	7.9	23.0	2.71	3.14
Kenton County	52 690	71.0	36.7	55.7	28.5	12.2	6.8	29.0	25.2	15.3	10.1	8.1	20.5	2.66	3.23
Knott County	6 086	80.6	44.2	64.5	35.9	12.6	8.8	19.4	18.2	10.0	8.0	6.1	20.7	2.86	3.26
Knox County	10 718	77.7	40.5	59.6	30.7	14.8	8.4	22.3	20.9	13.3	11.2	8.9	24.5	2.72	3.15
Larue County	4 503	76.0	34.1	64.1	28.1	9.0	4.9	24.0	22.4	14.1	12.4	9.7	27.5	2.56	2.99
Laurel County	15 585	80.6	41.5	66.6	33.7	11.2	6.4	19.4	17.7	11.1	8.4	6.6	20.9	2.75	3.11
Lawrence County	5 007	78.6	39.6	65.1	33.6	10.4	5.0	21.4	20.2	12.5	11.4	8.3	24.9	2.77	3.21
Lee County	2 760	77.1	38.0	61.7	29.4	12.1	7.1	22.9	21.7	13.3	11.6	9.0	26.2	2.65	3.07
Leslie County	4 711	82.6	45.7	66.5	37.3	12.7	6.6	17.4	16.0	8.9	6.8	5.1	18.6	2.88	3.21
Letcher County	9 731	79.1	42.2	64.2	35.0	11.8	5.8	20.9	19.7	12.6	10.2	8.1	23.1	2.76	3.18
Lewis County	4 713	78.3	40.3	65.2	33.8	9.7	4.9	21.7	19.7	11.8	10.9	7.9	25.4	2.74	3.14
Lincoln County	7 431	77.9	37.7	64.9	31.0	9.7	5.3	22.1	20.2	12.8	11.2	8.7	26.2	2.67	3.08
Livingston County	3 593	75.5	32.9	65.5	28.8	7.5	3.2	24.5	22.7	13.2	11.0	8.4	25.8	2.49	2.93
Logan County	9 302	75.2	35.9	62.2	29.3	9.9	5.2	24.8	23.0	14.9	12.7	10.2	26.7	2.60	3.06
Lyon County	2 355	71.4	26.7	61.8	22.0	7.3	3.8	28.6	27.2	16.8	15.5	11.5	32.4	2.31	2.79
McCracken County	25 625	70.6	32.5	56.5	24.1	11.7	7.2	29.4	27.0	17.7	13.2	10.9	26.9	2.41	2.93
McCreary County	5 479	78.6	41.9	60.9	32.2	14.4	8.2	21.4	20.1	12.9	10.3	8.0	23.1	2.80	3.23
McLean County	3 672	76.3	35.1	65.6	29.5	8.2	4.4	23.7	21.6	13.5	12.3	9.7	27.4	2.59	3.02
Madison County	20 012	72.8	35.3	59.5	27.9	10.6	6.2	27.2	21.8	13.4	8.7	6.9	19.3	2.56	3.01
Magoffin County	4 440	82.2	46.2	68.7	38.5	10.5	6.1	17.8	16.8	9.8	8.6	6.6	19.8	2.90	3.26
Marion County	5 688	76.6	39.7	60.4	31.0	12.7	7.2	23.4	21.3	13.0	10.7	8.6	24.5	2.77	3.24
Marshall County	10 789	76.9	32.5	67.9	27.5	6.9	4.1	23.1	21.5	13.4	11.6	9.1	27.7	2.48	2.88
Martin County	4 300	82.3	48.0	67.0	39.5	12.2	6.9	17.7	16.6	10.0	8.3	6.0	18.9	2.91	3.28
Mason County	6 537	72.6	34.7	58.2	27.2	11.5	6.3	27.4	25.3	16.4	13.7	10.6	28.1	2.52	3.02
Meade County	8 080	83.4	50.0	72.5	43.7	7.9	4.7	16.6	14.4	7.4	5.6	4.1	13.9	2.98	3.21
Menifee County	1 842	78.6	38.0	66.0	31.7	9.6	5.2	21.4	19.8	12.2	10.4	7.6	23.7	2.68	3.07
Mercer County	7 413	75.9	33.9	63.1	27.8	9.9	4.7	24.1	22.1	14.7	11.6	9.2	26.1	2.56	3.00
Metcalfe County	3 433	76.5	35.1	64.4	29.1	8.9	4.6	23.5	22.0	14.5	12.5	9.8	27.4	2.57	3.00
Monroe County	4 505	74.8	34.6	61.4	28.1	10.1	5.0	25.2	23.9	15.8	13.2	10.3	28.2	2.50	2.96
Montgomery County	7 312	77.1	37.6	63.7	30.3	10.8	6.2	22.9	20.9	14.0	10.2	8.4	23.3	2.64	3.06
Morgan County	4 089	79.2	39.8	66.7	33.5	9.4	4.9	20.8	19.6	12.2	10.6	7.9	24.5	2.74	3.15
Muhlenberg County	11 683	76.9	36.6	64.4	30.3	9.9	5.2	23.1	21.5	14.6	12.6	10.2	27.2	2.62	3.05
Nelson County	10 417	77.8	42.2	62.4	33.5	11.8	6.7	22.2	19.7	11.6	8.6	6.7	19.8	2.80	3.23
Nicholas County	2 621	74.2	35.1	61.3	28.3	9.4	5.5	25.8	23.9	15.6	14.1	11.0	29.0	2.54	3.00
Ohio County	7 816	77.9	37.5	66.7	31.4	8.3	4.7	22.1	20.8	13.0	11.8	8.9	26.4	2.66	3.08
Oldham County	10 673	83.8	47.4	72.9	40.7	8.5	5.4	16.2	13.8	7.5	5.1	3.9	12.8	2.93	3.24
Owen County	3 412	75.8	35.8	64.1	29.4	8.2	4.9	24.2	22.8	13.2	11.8	8.9	26.3	2.6[illegible]	3.06
Owsley County	1 848	78.7	37.5	63.4	29.2	11.0	5.7	21.3	19.6	10.3	10.0	7.0	27.1	2.67	3.25
Pendleton County	4 332	77.5	39.5	66.0	33.4	8.7	4.8	22.5	20.7	12.4	10.4	7.8	23.0	2.76	3.20
Perry County	10 598	79.7	42.7	63.9	35.2	12.4	5.8	20.3	19.0	11.6	8.9	6.9	20.9	2.83	3.25
Pike County	26 148	80.2	43.0	66.3	35.8	11.0	6.0	19.8	18.6	11.5	8.5	6.6	20.3	2.75	3.14
Powell County	4 057	80.1	43.4	64.9	34.6	12.1	7.2	19.9	17.8	10.3	8.7	6.5	20.6	2.36	3.24
Pulaski County	18 866	76.4	35.3	64.0	28.6	9.8	5.6	23.6	21.7	13.7	10.8	8.5	24.8	2.57	2.99
Robertson County	820	70.1	31.8	59.1	26.0	6.3	3.5	29.9	27.7	17.6	16.1	12.1	32.4	2.57	3.12
Rockcastle County	5 464	77.9	38.5	64.6	31.5	10.7	5.7	22.1	20.7	12.5	11.0	8.2	24.6	2.68	3.10
Rowan County	6 755	70.6	34.0	57.1	26.4	10.9	6.6	29.4	24.2	14.7	9.2	7.1	20.6	2.49	2.97
Russell County	5 896	74.9	33.0	62.0	26.9	10.1	5.0	25.1	23.8	15.5	12.6	9.7	27.8	2.48	2.92
Scott County	8 501	77.6	40.3	63.7	31.8	10.9	6.8	22.4	19.9	12.1	9.1	7.1	19.9	2.63	3.09
Shelby County	9 048	77.7	36.5	64.2	29.5	10.7	5.9	22.3	20.1	12.8	9.8	7.9	22.6	2.65	3.24
Simpson County	5 767	75.3	36.9	60.4	28.4	11.9	7.1	24.7	22.7	14.6	11.6	9.5	25.2	2.59	3.24
Spencer County	2 451	79.4	38.6	69.0	32.9	7.5	4.2	20.6	18.5	10.2	9.2	6.7	22.3	2.75	3.14
Taylor County	8 216	75.8	35.4	64.2	29.0	9.6	5.5	24.2	22.4	14.9	11.0	8.9	24.4	2.52	2.96
Todd County	4 104	75.7	35.5	62.3	29.1	10.5	5.2	24.3	22.3	14.4	12.8	10.1	28.6	2.54	3.10
Trigg County	4 104	75.7	30.6	64.3	24.8	8.5	4.7	24.3	22.8	13.8	13.5	9.9	32.2	2.49	2.92
Trimble County	2 246	79.9	38.7	70.3	33.4	6.9	3.9	20.1	18.3	11.3	9.8	7.4	24.3	2.68	3.05
Union County	5 580	75.0	38.9	60.9	30.9	11.2	6.5	25.0	23.1	14.5	11.9	9.4	25.3	2.65	3.14
Warren County	28 819	69.4	34.5	55.8	26.7	10.8	6.4	30.6	24.6	14.9	9.1	7.4	19.6	2.52	3.03
Washington County	3 709	78.4	38.2	65.7	32.0	10.2	5.3	21.6	19.9	12.8	11.3	9.1	27.6	2.76	3.19
Wayne County	6 517	78.7	37.7	65.4	30.8	10.3	5.7	21.3	19.8	12.5	10.3	7.6	25.7	2.66	3.05
Webster County	5 372	75.0	35.9	62.2	29.4	10.1	5.4	25.0	23.5	15.3	13.6	10.9	28.7	2.56	3.03
Whitley County	12 153	76.4	38.5	59.8	29.5	13.8	7.9	23.6	21.8	14.2	10.9	8.9	24.6	2.65	3.10
Wolfe County	2 451	75.8	39.7	59.9	30.4	12.4	7.5	24.2	22.9	12.2	10.1	7.2	22.4	2.63	3.08
Woodford County	7 223	79.1	39.7	67.3	33.2	9.2	5.3	20.9	18.1	11.3	7.9	6.3	18.8	2.71	3.09
PLACE AND COUNTY SUBDIVISION															
Albany city	891	64.6	29.3	44.1	17.6	18.4	10.7	35.4	34.2	24.6	20.0	16.5	33.8	2.23	2.54
Alexandria city	1 898	82.1	44.7	72.7	39.8	7.2	3.8	17.9	16.4	11.0	8.1	7.0	18.1	2.95	3.22
Anchorage city	654	87.5	51.2	80.4	47.7	5.2	2.9	12.5	11.2	8.3	5.5	4.4	14.8	3.13	3.40
Ashland city	10 128	67.8	27.9	52.6	19.9	12.9	7.2	32.2	30.3	21.0	16.4	13.6	32.4	2.30	2.87
Auburn city	512	68.8	28.1	56.4	23.2	10.4	4.3	31.3	30.5	21.5	18.9	16.0	35.9	2.26	2.95
Audubon Park city	603	70.6	30.2	61.7	27.5	6.8	2.3	29.4	27.4	22.6	17.7	15.9	34.0	2.52	3.10
Augusta city	525	70.9	35.6	51.6	23.4	14.5	9.1	29.1	27.6	19.4	17.0	14.7	30.9	2.54	3.10
Barbourmeade city	504	89.7	35.7	82.5	32.9	5.4	2.2	10.3	9.9	6.9	4.4	3.0	25.0	2.78	2.97
Barbourville city	1 347	68.3	33.0	44.6	20.0	21.0	12.0	31.7	30.0	20.4	16.2	13.4	29.8	2.39	2.98
Bardstown city	2 661	68.3	34.3	46.4	21.1	18.6	11.6	31.7	29.1	19.8	13.8	11.5	26.6	2.49	3.07

Table 2. **Summary of General Characteristics of Households and Families: 1990**—Con.

[For definitions of terms and meanings of symbols, see text]

State / Urban and Rural and Size of Place / Inside and Outside Metropolitan Area / County / Place and [In Selected States] County Subdivision [1,000 or More Persons]	All households	Percent of all households: Family households: Total	Family households: With own children under 18 years	Married-couple family: Total	Married-couple family: With own children under 18 years	Female householder, no husband present: Total	Female householder, no husband present: With own children under 18 years	Nonfamily households: Total	Householder living alone: Total	Householder living alone: Female	65 years and over: Total	65 years and over: Female	Householder 65 years and over	Persons per—: Household	Family
PLACE AND COUNTY SUBDIVISION—Con.															
Harrodsburg city	3 102	66.8	29.5	49.2	21.0	14.4	6.8	33.2	31.2	23.5	17.6	14.9	32.5	2.32	2.90
Hartford city	1 026	67.8	33.1	52.3	23.2	12.1	8.2	32.2	30.6	22.9	18.8	15.7	33.4	2.35	2.92
Hazard city	2 082	69.9	35.2	48.6	23.4	18.3	10.5	30.1	28.2	18.8	14.5	11.6	27.5	2.50	3.07
Henderson city	10 548	68.9	33.6	52.2	22.7	14.1	8.7	31.1	28.3	18.4	12.9	10.6	24.6	2.41	2.96
Hendron CDP	1 516	72.8	31.7	63.5	25.9	7.1	4.9	27.2	24.1	15.7	9.0	7.5	21.8	2.42	2.88
Hickman city	1 080	68.3	32.0	46.1	19.9	20.0	11.5	31.7	30.4	21.6	19.7	16.6	35.3	2.47	3.09
Highland Heights city	1 725	68.7	27.7	56.5	22.8	9.1	4.0	31.3	27.3	19.1	13.3	10.8	26.6	2.43	2.99
Highview CDP	5 336	79.8	37.1	68.5	31.7	8.8	4.4	20.2	16.8	9.0	5.5	4.5	[illegible]	[illegible]	[illegible]
Hillview city	[illegible] 846	90.5	52.0	75.7	43.9	11.4	6.1	9.5	8.1	4.2	2.1	1.6	6.6	3.31	3.48
Hodgenville city	1 132	65.9	29.0	47.1	18.4	16.8	10.0	34.1	31.8	23.7	19.8	16.7	35.5	2.28	2.86
Hopkinsville city	11 402	70.4	33.6	50.2	22.1	17.4	10.3	29.6	26.7	17.4	12.6	10.1	24.9	2.50	3.04
Horse Cave city	948	66.9	33.0	48.3	23.4	15.3	8.3	33.1	31.4	21.9	18.4	14.1	33.0	2.41	3.03
Hurstbourne city	1 838	71.2	25.4	65.7	23.4	4.1	1.5	28.8	27.0	20.2	14.9	13.1	28.6	2.40	2.93
Hurstbourne Acres city	580	47.6	13.1	40.3	10.3	5.3	2.1	52.4	43.8	21.0	5.7	4.8	15.7	1.85	2.56
Independence city	3 443	84.6	48.8	69.6	39.4	11.8	7.7	15.4	13.0	7.7	4.0	3.1	11.9	3.02	3.31
Indian Hills city	410	83.2	30.5	77.1	28.0	4.6	1.5	16.8	15.1	10.5	9.3	8.0	33.7	2.62	2.90
Indian Hills Cherokee Section city	351	84.6	44.2	81.8	41.3	4.3	2.6	13.4	12.8	7.1	6.3	4.0	23.4	2.86	3.14
Irvine city	1 146	68.5	31.7	48.1	20.2	18.4	10.9	31.5	29.9	22.4	18.5	15.5	34.0	2.38	2.95
Irvington city	477	67.9	32.1	49.7	21.2	15.7	9.9	32.1	30.0	22.2	17.0	13.6	30.4	2.47	3.06
Jackson city	911	72.1	35.9	53.5	25.4	16.2	10.0	27.9	26.8	18.1	12.8	11.2	24.5	2.45	2.97
Jamestown city	660	67.1	29.7	50.9	20.6	14.1	8.5	32.9	31.5	21.1	16.2	12.1	32.9	2.33	2.93
Jeffersontown city	8 900	73.8	37.7	61.1	30.8	10.0	5.7	26.2	22.1	13.2	5.1	4.2	12.7	2.58	3.04
Jeffersonville city	656	80.6	44.4	68.6	34.7	9.6	6.1	19.4	16.8	8.8	8.5	6.4	18.9	2.83	3.19
Jenkins city	1 025	76.1	40.9	56.9	29.6	16.7	10.0	23.9	22.6	14.5	12.4	9.7	26.5	2.64	3.12
Junction City city	761	75.7	38.6	55.8	27.3	16.6	9.9	24.3	23.0	14.6	10.2	8.7	23.3	2.61	3.03
La Center city	409	67.5	27.9	57.0	21.8	8.3	4.9	32.5	30.8	22.2	18.6	16.1	37.7	2.32	2.87
La Grange city	1 454	70.6	37.6	51.2	25.6	15.7	9.9	29.4	26.1	17.1	13.2	10.3	24.6	2.54	3.06
Lakeside Park city	1 250	68.2	31.7	56.6	26.6	9.4	4.2	31.8	26.5	17.7	11.2	9.6	24.8	2.50	3.08
Lancaster city	1 440	68.9	28.5	51.0	19.3	15.8	8.1	31.1	29.2	21.5	17.9	15.1	36.6	2.30	2.82
Lawrenceburg city	2 351	72.1	34.2	57.5	26.2	12.0	6.6	27.9	25.6	18.3	13.7	11.5	26.9	2.47	2.97
Lebanon city	2 243	69.4	32.9	46.9	20.1	19.4	11.8	30.6	28.4	20.1	15.7	13.1	31.3	2.48	3.05
Lebanon Junction city	650	75.7	38.5	62.0	32.0	10.3	5.5	24.3	22.0	14.8	12.5	9.4	24.3	2.58	3.13
Ledbetter CDP	614	83.4	45.1	71.8	38.1	9.8	5.9	16.6	15.3	9.6	5.4	3.7	14.8	2.76	3.06
Leitchfield city	1 990	69.0	35.3	50.0	22.9	15.5	10.5	31.0	28.8	19.7	14.3	11.3	26.0	2.39	2.91
Lewisport city	643	77.3	44.3	60.8	32.5	13.5	10.1	22.7	21.5	13.5	9.5	7.8	18.2	2.65	3.07
Lexington-Fayette	89 529	63.0	30.3	48.3	22.1	12.2	7.3	37.0	29.1	17.1	7.8	6.4	16.2	2.38	2.98
Liberty city	842	65.7	29.8	47.1	18.9	15.7	9.5	34.3	33.4	25.2	20.3	17.5	37.5	2.24	2.85
Livermore city	603	71.3	34.2	58.7	26.7	9.8	6.8	28.7	25.9	18.1	15.8	12.4	29.0	2.54	3.07
London city	2 343	66.2	30.0	51.8	22.2	11.6	6.4	33.8	31.7	22.7	16.3	14.2	30.2	2.33	2.94
Louisa city	801	67.5	29.5	49.2	21.8	15.6	7.2	32.5	31.3	23.3	18.6	15.7	32.1	2.35	2.94
Louisville city	113 065	59.6	26.2	37.9	14.7	18.3	10.2	40.4	35.0	21.5	14.1	11.1	27.1	2.31	3.02
Loyall city	416	75.2	35.8	59.4	29.1	13.7	5.8	24.8	23.1	16.6	10.8	9.1	26.4	2.64	3.13
Ludlow city	1 783	70.9	35.3	52.4	26.6	14.8	7.4	29.1	25.6	16.9	12.5	10.5	25.7	2.66	3.21
Lynch city	460	77.0	31.5	61.3	24.6	13.3	6.7	23.0	22.4	17.2	15.4	13.7	40.2	2.53	2.97
Lyndon city	3 842	52.8	21.9	42.1	16.1	8.8	5.0	47.2	38.7	20.6	5.9	4.6	13.0	2.25	2.77
Lynnview city	439	69.0	26.0	55.1	20.7	12.1	4.8	31.0	29.2	22.1	17.3	14.6	35.1	2.22	2.84
McRoberts CDP	385	82.1	40.8	66.3	34.8	13.0	4.2	17.9	17.1	12.5	10.1	8.6	25.2	2.56	3.24
Madisonville city	6 532	69.7	32.7	52.7	23.0	14.2	8.4	30.3	28.1	19.2	14.0	11.6	28.6	2.40	2.94
Manchester city	665	68.4	29.8	49.0	20.8	16.1	6.9	31.6	30.1	20.3	19.4	15.9	35.0	2.39	2.95
Marion city	1 437	64.1	26.9	50.6	19.6	11.8	6.6	35.9	34.4	25.3	21.4	17.7	37.4	2.20	2.92
Masonville CDP	380	83.2	47.1	70.5	39.2	9.7	6.1	16.8	12.4	6.8	2.9	2.4	11.8	2.94	3.23
Massac CDP	1 424	80.0	42.3	67.9	33.6	10.2	7.9	20.0	17.9	11.0	6.2	5.2	15.5	2.62	2.98
McAfee city	4 462	62.4	26.5	47.3	17.6	13.4	8.3	37.6	36.1	26.4	21.9	18.6	37.9	2.18	2.83
Maysville city	3 088	62.2	27.7	44.9	18.8	14.3	7.8	37.8	35.2	25.0	19.7	16.1	34.1	2.27	2.93
Middlesborough city	4 478	72.7	34.1	51.0	22.8	18.6	10.1	27.3	25.3	17.4	14.2	11.5	29.6	2.51	3.21
Middletown city	2 019	74.1	35.8	61.0	27.5	11.2	7.3	25.9	22.8	15.4	8.8	7.7	18.7	2.48	2.93
Midway city	451	71.6	30.4	59.2	25.3	10.0	4.2	28.4	25.7	18.4	12.4	11.3	24.4	2.51	3.02
Minor Lane Heights city	521	86.6	49.9	68.9	39.2	10.9	7.5	13.4	10.2	5.2	3.5	2.5	8.6	3.21	3.44
Monticello city	2 174	70.5	31.7	52.5	21.4	15.4	9.3	29.5	28.1	20.3	15.6	12.6	32.3	2.41	2.95
Morehead city	2 175	59.4	27.2	44.1	18.3	13.1	8.3	40.6	32.8	21.3	13.3	10.5	23.7	2.22	2.96
Morganfield city	1 436	72.4	37.4	54.5	26.9	15.4	9.4	27.6	25.7	17.8	13.9	11.6	29.0	2.57	3.10
Morgantown city	888	68.1	34.1	48.8	23.0	16.6	10.4	31.9	29.7	23.5	16.9	14.6	31.4	2.37	2.95
Mount Sterling city	2 209	65.3	29.1	48.4	19.9	14.6	8.5	34.7	32.4	24.1	18.2	15.6	33.3	2.31	2.94
Mount Vernon city	1 084	71.5	33.8	52.6	22.5	16.7	10.3	28.5	28.0	22.0	15.8	14.2	31.1	2.39	2.91
Mount Washington city	1 816	83.0	49.1	65.7	37.7	14.3	10.0	17.0	14.8	9.6	6.1	5.3	14.0	2.88	3.20
Muldraugh city	562	68.3	35.9	54.4	27.6	11.2	7.3	31.7	26.2	9.4	5.2	3.9	10.9	2.45	2.99
Munfordville city	660	65.8	28.6	45.5	18.8	18.0	9.4	34.2	32.4	23.0	17.7	14.2	35.0	2.29	2.89
Murray city	5 179	57.4	23.7	45.9	17.0	10.0	6.0	42.6	35.1	23.4	15.7	13.5	29.9	2.11	2.75
Newburg CDP	7 752	75.7	41.0	44.8	20.6	27.0	18.5	24.3	20.5	10.5	5.3	3.8	14.2	2.77	3.19
Newport city	7 266	63.9	33.5	40.3	20.1	19.3	11.3	36.1	31.2	17.7	12.5	9.7	22.7	2.57	3.27
Nicholasville city	4 947	77.4	43.3	60.3	32.9	13.7	8.7	22.6	19.0	13.0	7.8	6.7	16.4	2.71	3.10
North Corbin CDP	614	76.9	39.9	59.0	29.8	14.3	8.6	23.1	21.7	12.4	11.4	8.5	26.5	2.61	3.01
Normandy city	486	75.1	32.5	61.7	28.0	11.1	3.7	24.9	24.3	18.3	16.5	13.4	31.9	2.49	2.95
Oakbrier CDP	1 516	76.5	42.5	69.7	38.5	5.2	3.1	23.5	20.4	10.8	2.4	2.0	6.3	2.71	3.18
Oak Grove city	1 101	74.3	44.3	61.9	34.3	9.9	8.5	25.7	18.4	4.9	1.9	.7	4.1	2.60	2.95
Okolona CDP	7 122	76.4	36.0	58.7	26.5	14.1	7.9	23.6	20.2	12.8	7.5	6.3	19.2	2.64	3.04
Olive Hill city	780	65.5	27.9	50.5	20.9	13.1	6.2	34.5	32.9	23.3	17.9	14.1	34.2	2.32	2.95
Orchard Grass Hills city	322	88.8	62.1	77.6	54.3	9.3	5.9	11.2	8.4	3.6	1.2	1.2	2.5	3.29	3.50
Owensboro city	21 672	66.7	32.2	50.4	22.6	13.8	8.5	33.3	30.1	19.8	13.4	11.3	25.2	2.39	2.99
Owenton city	561	60.6	25.5	46.7	17.8	12.3	7.0	39.4	39.0	29.4	23.0	20.3	37.1	2.12	2.82

Reference 33

Water Resources Data
Kentucky
Water Year 1991

by D.L. McClain, F.D. Byrd, and A.C. Brown

U.S. GEOLOGICAL SURVEY WATER-DATA REPORT KY-91-1
Prepared in cooperation with the Commonwealth of
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16. Abstract (Limit: 200 words)

Water-resources data for the 1991 water year for Kentucky consists of records of Stage, discharge, and water quality of streams; stage and water levels of wells. This report contains discharge records from 115 gaging stations; suspended-sediment data for 12 stations (5 daily); daily temperature records for 13 stations; daily specific conductance for 8 stations; ground-water levels for 23 continuous-record wells and 117 partial-record wells; water-quality data from 38 surface-water stations sampled at regular intervals; and miscellaneous temperature and specific conductance data from 85 gaging stations. Also included is 1 precipitation site. Data collected at various miscellaneous sites are also published. These data represent that part of the National Water Data System operated by the U.S. Geological Survey and cooperating State and Federal agencies in Kentucky.

17. Document Analysis a. Descriptors

*Kentucky, *Hydrologic data, *Surface waters, *Water quality, *Ground waters, Gaging stations, Streamflow, Flow rates, Lakes, Wells, Chemical analyses, Suspended sediments, Water temperature, Water levels.

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OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

SALT RIVER BASIN

03302000 POND CREEK NEAR LOUISVILLE, KY

LOCATION.--Lat 38°07'11", long 85°47'45", Jefferson County, Hydrologic Unit 05140102, on upstream side of bridge on Manslick Road, right bank, 0.4 mi south of Third Street Road, 0.6 mi downstream from Bee Lick Creek, 1.5 mi downstream from confluence of Northern and Southern Ditches, 2.4 mi south of Louisville city limits, and at mile 15.4.

DRAINAGE AREA.--64.0 mi^2.

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.--August 1944 to current year.

REVISED RECORDS.--WSP 1705: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 430.38 ft above National Geodetic Vertical Datum of 1929. See WDR KY-90-1 for history of changes prior to Nov. 16, 1962.

REMARKS.--Estimated daily discharges: Oct. 30 to Nov. 1, Jan. 1-2, Feb. 17 to Mar. 3, Mar. 20-29, May 5-16, June 18 to July 1, July 10-25. Water-discharge records good. Records include small amount of inflow diverted by manufacturing plants from Louisville water supply, which is pumped from Ohio River.

EXTREMES OUTSIDE PERIOD OF RECORD.--Flood in January 1937 reached a stage of about 23 ft present datum, backwater from Ohio River, from information by local residents.

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991--DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	8.7	12	22	350	93	45	32	19	20	10	14	94
2	7.3	11	23	148	80	60	27	18	59	15	9.9	17
3	6.9	11	791	110	58	55	21	17	22	32	11	12
4	554	10	156	84	55	39	30	21	20	15	11	243
5	64	18	67	141	103	33	23	520	18	12	8.9	129
6	27	17	39	589	352	99	17	150	15	11	9.4	30
7	19	12	24	893	163	88	10	50	15	10	9.4	19
8	16	10	19	556	159	53	8.6	160	15	10	9.5	14
9	111	80	16	403	127	39	7.3	360	14	12	67	12
10	486	231	15	327	84	32	32	200	13	240	64	14
11	81	46	14	539	76	29	34	145	13	500	14	46
12	43	26	15	492	244	51	29	110	13	150	9.9	17
13	29	23	21	314	126	231	22	87	13	50	11	13
14	23	20	16	254	255	112	13	70	13	30	10	11
15	21	17	424	215	156	126	11	59	12	20	8.0	10
16	19	17	122	258	129	89	21	50	11	15	7.5	9.5
17	17	17	325	208	100	131	29	48	35	15	7.0	10
18	41	15	754	164	200	185	25	58	120	14	38	13
19	23	15	505	133	110	108	128	35	360	14	25	19
20	20	13	206	117	75	250	54	24	105	14	66	9.4
21	19	12	239	109	65	900	35	24	67	13	18	6.6
22	514	124	528	76	60	820	28	24	48	13	12	6.0
23	149	184	480	51	55	650	24	21	37	12	11	6.3
24	55	54	187	43	50	450	92	18	30	15	9.0	7.1
25	36	32	114	38	47	310	31	23	24	13	8.0	24
26	27	23	83	35	44	210	24	44	20	11	7.5	10
27	24	21	68	30	40	145	21	104	18	12	8.1	6.4
28	23	145	226	264	37	100	21	40	15	11	16	5.3
29	21	52	551	117	---	68	41	21	14	11	40	4.7
30	17	26	954	272	---	47	23	17	12	11	156	4.2
31	15	---	810	229	---	42	---	13	---	11	77	---
TOTAL	2516.9	1294	7814	7559	3143	5597	913.9	2550	1191	1322	773.1	822.5
MEAN	81.2	43.1	252	244	112	181	30.5	82.3	39.7	42.6	24.9	27.4
MAX	554	231	954	893	352	900	128	520	360	500	156	243
MIN	6.9	10	14	30	37	29	7.3	13	11	10	7.0	4.2
CFSM	1.27	.67	3.94	3.81	1.75	2.82	.48	1.29	.62	.67	.39	.43
IN.	1.46	.75	4.54	4.39	1.83	3.25	.53	1.48	.69	.77	.45	.48

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1944 - 1991, BY WATER YEAR (WY)

MEAN	26.9	59.8	99.9	130	166	183	139	103	61.3	46.0	31.5	32.3
MAX	117	256	310	614	454	738	551	505	304	282	150	399
(WY)	1976	1974	1979	1950	1989	1964	1970	1983	1950	1973	1970	1979
MIN	1.76	2.80	4.48	8.52	10.1	11.4	22.0	10.6	4.54	2.96	.78	1.15
(WY)	1947	1945	1954	1977	1954	1954	1954	1954	1954	1952	1945	1945

SUMMARY STATISTICS	FOR 1990 CALENDAR YEAR		FOR 1991 WATER YEAR		WATER YEARS 1944 - 1991	
ANNUAL TOTAL	46397.0		35496.4			
ANNUAL MEAN	127		97.3		89.5	
HIGHEST ANNUAL MEAN					159	1950
LOWEST ANNUAL MEAN					11.4	1954
HIGHEST DAILY MEAN	3090	May 17	954	Dec 30	6340	Mar 10 1964
LOWEST DAILY MEAN	3.3	Aug 3	4.2	Sep 30	.10	Sep 3 1945
ANNUAL SEVEN-DAY MINIMUM	5.0	Jul 29	8.8	Sep 24	.19	Sep 17 1945
INSTANTANEOUS PEAK FLOW			2770	Dec 31	8020	Mar 9 1964
INSTANTANEOUS PEAK STAGE			17.15	Dec 31	22.69	Mar 9 1964
ANNUAL RUNOFF (CFSM)	1.99		1.52		1.40	
ANNUAL RUNOFF (INCHES)	26.97		20.63		18.99	
10 PERCENT EXCEEDS	281		254		186	
50 PERCENT EXCEEDS	33		30		26	
90 PERCENT EXCEEDS	8.6		10		5.2	

WATER-QUALITY RECORDS

PERIOD OF RECORD.--February 1988 to current year.

PERIOD OF DAILY RECORD.--
SPECIFIC CONDUCTANCE: May 1988 to current year.
pH: May 1988 to current year.
WATER TEMPERATURE: May 1988 to current year.
DISSOLVED OXYGEN: June 1988 to current year.

INSTRUMENTATION.--Water-quality monitor since May 1988.

REMARKS.--Water-quality samples were collected monthly. Records good for specific conductance, pH, water temperature, and dissolved oxygen.

COOPERATION.--Field determinations were made in cooperation with Louisville and Jefferson County Metropolitan Sewer District personnel.

EXTREMES FOR PERIOD OF RECORD.--
SPECIFIC CONDUCTANCE: Maximum, 1200 microsiemens, Nov. 4, 1988; minimum, 129 microsiemens, Mar. 6, 1989.
pH: Maximum, 10.1 units, Apr. 16, 17, 18, 1991; minimum, 4.5 units, Oct. 18, 1990.
WATER TEMPERATURE: Maximum, 34.0°C, July 15-17 and Aug. 2, 4, and 16, 1988; minimum, 0.0°C, Jan. 22, 23, 1991.
DISSOLVED OXYGEN: Maximum, 20.1 mg/L, June 30, 1991; minimum, 0.7 mg/L, July 3, 1991.

EXTREMES FOR CURRENT YEAR.--
SPECIFIC CONDUCTANCE: Maximum, 1010 microsiemens, Jan. 27; minimum, 164 microsiemens, Sept. 4.
pH: Maximum, 10.7 units, Apr. 16, 17, 18; minimum, 4.5 units, Oct. 18.
WATER TEMPERATURE: Maximum, 33.6°C, July 22; minimum, 0.0°C, Jan. 22, 23.
DISSOLVED OXYGEN: Maximum, 20.1 mg/L, June 30; minimum, 0.7 mg/L, Jul. 3.

WATER QUALITY DATA, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

DATE	TIME	STREAM-FLOW, INSTAN-TANEOUS (FT^3/S)	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE WATER (DEG C)	OXYGEN, DIS-SOLVED (MG/L)
OCT						
02...	1040	7.6	642	7.7	19.5	8.0
NOV						
01...	1110	11	642	8.1	15.0	10.6
DEC						
03...	1520	850	270	8.9	13.0	8.1
JAN						
03...	0938	102	516	7.8	4.0	10.6
FEB						
04...	1020	51	594	8.0	7.5	11.2
MAR						
04...	1025	40	585	7.7	5.0	11.4
APR						
01...	1020	36	558	8.5	12.0	9.6
MAY						
01...	1125	19	572	8.3	20.0	6.3
JUN						
03...	1010	22	476	7.5	27.5	2.8
JUL						
01...	1030	9.6	632	8.5	30.5	6.2
AUG						
05...	1030	11	607	8.3	26.5	6.1
SEP						
03...	1105	11	521	7.6	26.5	4.6

SALT RIVER BASIN

03302000 POND CREEK NEAR LOUISVILLE, KY--Continued

SPECIFIC CONDUCTANCE, US/CM @ 25 DEGREES CENTIGRADE, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		OCTOBER			NOVEMBER			DECEMBER			JANUARY	
1	653	631	641	---	---	---	624	607	616	469	417	446
2	653	640	645	656	628	640	633	625	630	504	470	488
3	651	635	644	656	630	641	629	436	494	526	505	516
4	650	257	363	677	646	657	485	438	461	544	527	536
5	455	371	416	701	566	647	520	485	504	559	500	548
6	499	454	475	668	572	618	558	521	536	495	377	447
7	520	498	507	617	594	603	575	550	563	377	337	358
8	548	521	534	627	601	609	596	576	587	423	374	399
9	577	360	523	627	393	570	614	596	606	467	424	445
10	394	294	336	465	373	415	630	614	622	507	468	489
11	450	396	426	539	467	506	647	630	639	509	465	478
12	489	452	470	572	540	558	658	647	653	490	465	477
13	522	488	515	589	574	582	670	658	665	518	490	504
14	549	519	534	588	574	579	676	658	670	551	518	534
15	567	545	555	607	588	600	660	361	480	584	552	568
16	575	555	565	620	571	603	520	438	487	597	585	591
17	595	511	563	628	604	618	530	421	498	604	590	596
18	721	512	566	623	613	621	420	302	331	614	604	609
19	547	514	526	619	603	611	464	321	402	623	614	619
20	---	---	---	634	611	620	514	467	491	631	623	627
21	---	---	---	647	624	631	533	510	526	647	631	639
22	---	---	---	647	464	570	506	418	447	653	647	650
23	---	---	---	509	462	482	478	435	451	656	652	654
24	---	---	---	556	511	535	501	456	481	661	647	655
25	---	---	---	591	557	573	527	502	515	656	647	651
26	---	---	---	614	591	601	553	528	541	654	644	648
27	---	---	---	675	614	647	575	554	566	1010	644	730
28	---	---	---	680	542	599	649	575	599	737	525	588
29	---	---	---	587	563	575	647	498	537	565	527	548
30	---	---	---	607	587	598	521	319	460	573	488	538
31	---	---	---	---	---	---	415	316	364	539	488	511
MONTH	---	---	---	---	---	---	676	302	530	1010	337	551
		FEBRUARY			MARCH			APRIL			MAY	
1	565	540	555	615	578	607	563	551	558	580	565	573
2	583	559	571	575	540	548	573	562	568	604	572	585
3	591	583	588	578	552	566	574	562	568	612	582	598
4	604	582	593	592	578	586	571	559	565	616	594	610
5	615	592	610	604	592	596	579	570	574	612	331	475
6	587	398	456	603	487	572	579	568	573	524	433	486
7	466	418	438	528	486	511	583	572	577	615	526	571
8	508	466	487	547	530	540	577	527	547	664	615	639
9	529	508	518	562	546	555	536	525	530	668	589	619
10	549	529	541	571	560	566	543	530	537	631	592	610
11	560	549	554	577	567	573	550	529	539	626	536	584
12	573	561	567	588	540	582	562	526	554	547	479	526
13	577	462	553	533	403	436	513	434	456	537	489	512
14	462	401	423	430	404	414	497	454	479	581	414	534
15	472	429	451	473	431	454	514	494	503	474	405	436
16	524	474	504	503	475	492	514	507	510	525	474	503
17	571	526	544	521	462	508	537	513	526	565	526	546
18	599	374	446	455	426	436	543	534	538	593	536	568
19	479	415	448	473	449	461	540	445	482	551	515	529
20	501	479	492	493	474	485	494	451	476	583	543	567
21	529	501	514	512	459	502	517	495	507	616	580	600
22	550	529	541	452	326	392	544	518	532	632	586	601
23	564	550	558	420	344	376	565	540	552	617	575	596
24	577	565	571	459	421	442	563	483	513	621	591	604
25	593	577	585	492	460	482	545	489	517	624	572	615
26	599	594	596	502	478	493	568	546	558	577	505	536
27	604	597	601	503	477	490	585	566	577	507	411	473
28	610	604	607	525	503	517	598	583	591	537	471	497
29	---	---	---	532	523	527	598	564	584	582	530	556
30	---	---	---	543	532	538	593	565	580	673	569	622
31	---	---	---	551	543	548	---	---	---	623	562	608
MONTH	615	374	533	615	326	510	598	434	539	673	331	561

SALT RIVER BASIN

03302000 POND CREEK NEAR LOUISVILLE, KY--Continued

SPECIFIC CONDUCTANCE, US/CM @ 25 DEGREES CENTIGRADE, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		JUNE			JULY			AUGUST			SEPTEMBER	
1	614	591	604	698	589	640	649	583	631	467	363	412
2	509	390	436	659	596	631	626	552	583	516	468	492
3	524	472	493	583	441	538	626	615	618	530	515	521
4	540	522	533	624	566	590	619	610	615	529	164	377
5	560	490	535	632	591	613	632	606	612	480	335	413
6	602	491	555	613	566	597	645	622	634	533	479	501
7	627	568	593	629	577	608	655	637	645	575	508	530
8	597	574	585	643	587	622	659	643	650	622	564	584
9	624	542	580	656	599	632	660	363	596	661	624	636
10	582	515	552	632	213	327	486	434	469	688	661	674
11	671	609	641	452	331	388	501	472	482	672	526	562
12	782	643	692	488	455	464	549	501	523	568	530	553
13	786	678	732	497	465	479	563	551	557	609	565	584
14	762	690	731	499	480	489	577	559	569	623	599	611
15	806	644	710	527	493	506	614	576	597	626	617	623
16	706	641	677	581	522	543	620	602	610	655	626	644
17	702	430	599	617	581	600	625	618	621	665	656	660
18	526	234	420	617	604	609	621	520	575	656	630	642
19	464	336	402	621	613	616	533	502	513	635	522	581
20	563	460	530	627	619	623	506	427	466	590	547	569
21	566	168	409	639	624	632	529	506	513	601	544	564
22	486	310	401	655	635	643	556	526	536	594	546	572
23	561	487	525	642	629	634	562	543	553	640	585	612
24	585	553	570	646	621	632	579	560	569	650	602	634
25	646	582	607	645	624	634	606	573	589	629	377	476
26	643	609	623	671	629	647	851	599	685	575	465	545
27	703	603	630	670	644	658	844	602	722	619	552	592
28	781	707	748	697	660	679	876	444	608	648	619	636
29	786	717	753	695	673	685	546	380	431	671	630	646
30	762	699	731	683	660	668	624	387	469	688	656	671
31	---	---	---	662	639	650	586	351	423	---	---	---
MONTH	806	168	587	698	213	590	876	351	570	688	164	571

PH (STANDARD UNITS), WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		OCTOBER			NOVEMBER			DECEMBER			JANUARY	
1	8.3	7.4	7.8	---	---	---	7.3	7.1	7.2	7.8	7.6	7.7
2	7.8	7.2	7.6	8.3	8.1	8.2	7.3	7.3	7.3	7.8	7.7	7.8
3	7.3	7.1	7.2	8.2	8.0	8.1	7.3	7.3	7.3	7.9	7.8	7.8
4	7.3	5.3	5.9	8.0	8.0	8.0	7.3	7.3	7.3	7.9	7.8	7.9
5	6.1	5.2	5.6	8.0	7.8	7.9	7.6	7.3	7.6	7.9	7.6	7.8
6	6.6	5.8	6.1	7.9	7.8	7.8	7.6	7.5	7.6	7.7	7.6	7.7
7	6.6	6.4	6.5	7.8	7.8	7.8	7.6	7.5	7.5	7.8	7.6	7.7
8	6.8	6.4	6.6	7.8	7.7	7.8	7.6	7.5	7.5	7.9	7.8	7.8
9	6.8	6.2	6.5	7.7	7.6	7.7	7.5	7.5	7.5	7.9	7.9	7.9
10	6.2	5.9	6.1	7.6	7.5	7.6	7.6	7.5	7.5	8.0	7.9	8.0
11	6.1	5.7	5.9	7.6	7.5	7.5	7.6	7.5	7.5	7.9	7.7	7.8
12	6.0	5.7	5.8	7.5	7.4	7.5	7.5	7.5	7.5	7.8	7.8	7.8
13	6.1	5.7	5.9	7.5	7.4	7.5	7.5	7.5	7.5	7.8	7.7	7.8
14	6.4	5.8	6.1	7.7	7.4	7.5	8.1	7.5	7.7	7.8	7.6	7.7
15	6.6	6.1	6.3	7.7	7.5	7.6	8.1	7.1	7.5	7.8	7.7	7.7
16	6.7	6.2	6.5	7.7	7.6	7.6	7.5	7.2	7.4	7.8	7.6	7.7
17	7.0	6.2	6.6	7.7	7.6	7.6	7.5	7.2	7.4	7.8	7.8	7.8
18	6.3	4.5	5.4	7.6	7.5	7.5	7.2	6.9	7.0	7.8	7.7	7.8
19	5.6	5.1	5.2	7.6	7.5	7.5	7.3	7.0	7.2	7.8	7.7	7.7
20	---	---	---	7.5	7.4	7.5	7.4	7.3	7.4	7.7	7.6	7.7
21	---	---	---	7.5	7.3	7.4	7.4	7.3	7.4	7.7	7.6	7.7
22	---	---	---	7.4	7.3	7.4	7.4	7.2	7.3	7.7	7.7	7.7
23	---	---	---	7.4	7.3	7.4	7.5	7.4	7.4	7.7	7.6	7.6
24	---	---	---	7.4	7.3	7.3	7.6	7.5	7.6	7.6	7.5	7.6
25	---	---	---	7.3	7.3	7.3	7.7	7.5	7.6	7.7	7.5	7.6
26	---	---	---	7.3	7.3	7.3	7.8	7.6	7.7	7.7	7.6	7.6
27	---	---	---	7.4	7.3	7.3	7.8	7.8	7.8	7.8	7.7	7.7
28	---	---	---	7.3	7.2	7.3	7.8	7.5	7.7	7.8	7.7	7.8
29	---	---	---	7.2	7.2	7.2	7.5	7.4	7.5	7.8	7.7	7.8
30	---	---	---	7.2	7.1	7.1	7.5	7.3	7.4	8.0	7.8	7.9
31	---	---	---	---	---	---	7.6	7.3	7.4	8.0	7.8	7.9
MONTH	---	---	---	---	---	---	8.1	6.9	7.5	8.0	7.5	7.8

SALT RIVER BASIN

03302000 POND CREEK NEAR LOUISVILLE, KY--Continued

PH (STANDARD UNITS), WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		FEBRUARY			MARCH			APRIL			MAY	
1	8.0	7.9	8.0	8.5	8.0	8.3	8.7	8.5	8.6	8.5	8.3	8.4
2	8.1	7.9	8.0	8.0	7.6	7.8	8.8	8.6	8.7	9.1	8.5	8.8
3	8.0	7.9	8.0	7.7	7.5	7.6	8.8	8.4	8.5	9.2	8.6	8.9
4	8.0	7.9	8.0	7.8	7.6	7.7	8.9	8.6	8.7	9.2	8.6	8.8
5	7.9	7.8	7.9	7.6	7.5	7.6	9.1	8.7	8.8	8.9	8.2	8.5
6	8.1	7.6	7.9	7.5	7.3	7.4	9.5	8.8	9.0	8.5	8.2	8.4
7	8.0	7.9	8.0	7.3	7.2	7.2	9.5	9.0	9.2	8.5	8.3	8.4
8	8.1	7.9	8.0	7.3	7.1	7.2	9.4	8.8	9.0	8.9	8.4	8.7
9	7.9	7.9	7.9	7.1	7.0	7.1	9.4	9.0	9.2	8.8	8.2	8.4
10	7.9	7.8	7.9	7.3	7.1	7.2	10.0	9.3	9.5	8.7	7.9	8.2
11	7.9	7.8	7.9	7.4	6.9	7.2	10.3	9.5	9.9	8.9	8.6	8.7
12	7.9	7.8	7.8	7.3	6.8	7.0	10.3	9.4	10.0	9.1	8.1	8.8
13	8.0	7.7	7.8	7.4	7.2	7.3	9.6	9.3	9.5	8.2	7.7	7.9
14	8.1	7.7	7.9	7.4	7.2	7.3	10.0	9.6	9.7	7.7	7.3	7.5
15	7.9	7.9	7.9	7.2	6.9	7.1	10.3	9.6	9.9	7.4	7.2	7.3
16	8.0	7.9	8.0	7.0	6.7	6.8	10.7	9.9	10.1	7.3	7.2	7.3
17	8.0	7.9	7.9	7.3	6.7	6.9	10.7	10.0	10.4	7.3	7.2	7.2
18	8.1	7.6	7.9	7.2	6.8	7.0	10.7	9.9	10.3	7.3	7.2	7.3
19	7.7	7.6	7.7	7.0	6.8	6.9	10.5	9.4	9.7	7.4	7.3	7.3
20	7.8	7.6	7.6	7.3	7.0	7.1	9.8	9.5	9.6	7.5	7.4	7.4
21	8.2	7.8	8.0	7.3	7.0	7.1	10.0	9.5	9.7	7.5	7.5	7.5
22	8.3	8.1	8.2	7.5	7.0	7.3	10.1	9.5	9.8	8.8	7.5	7.7
23	8.2	8.0	8.1	7.8	7.3	7.5	10.1	9.5	9.8	8.2	7.8	7.9
24	8.1	8.0	8.1	7.9	7.7	7.7	10.0	8.8	9.2	8.0	7.7	7.8
25	8.2	8.1	8.1	8.1	7.7	7.9	9.6	9.0	9.3	8.1	7.7	7.9
26	8.3	8.1	8.2	8.0	7.8	7.9	9.5	8.9	9.2	7.8	7.5	7.7
27	8.4	8.0	8.2	8.1	7.8	7.9	9.6	8.7	9.1	7.6	7.1	7.4
28	8.4	8.2	8.3	8.3	8.1	8.1	9.0	8.4	8.7	7.5	7.0	7.2
29	---	---	---	8.4	8.1	8.2	8.5	8.1	8.3	7.2	6.7	7.0
30	---	---	---	8.7	8.4	8.4	8.3	8.0	8.1	8.4	7.5	8.1
31	---	---	---	8.7	8.4	8.5	---	---	---	9.0	8.1	8.4
MONTH	8.4	7.6	8.0	8.7	6.7	7.5	10.7	8.0	9.3	9.2	6.7	8.0
		JUNE			JULY			AUGUST			SEPTEMBER	
1	8.8	7.9	8.3	9.3	8.5	8.8	8.9	8.1	8.5	7.3	6.9	7.0
2	8.6	7.6	8.1	9.0	8.5	8.8	8.7	8.2	8.5	7.6	7.2	7.4
3	8.3	7.5	7.8	8.8	7.6	8.2	8.9	8.3	8.6	7.7	7.5	7.6
4	8.3	6.5	7.3	8.6	7.8	8.1	8.7	8.4	8.5	7.9	7.2	7.5
5	6.4	4.9	5.5	8.8	8.0	8.4	8.5	8.2	8.3	7.5	7.2	7.3
6	5.2	4.6	4.8	8.9	8.3	8.6	8.2	7.6	7.9	7.5	7.0	7.2
7	5.1	4.6	4.8	9.2	8.7	8.9	7.9	7.5	7.8	7.1	6.6	6.9
8	5.5	4.6	4.9	9.1	8.7	8.9	8.0	7.7	7.8	7.6	7.1	7.3
9	5.2	4.6	5.0	8.9	8.3	8.6	8.1	7.2	7.7	7.9	7.6	7.7
10	8.3	5.2	6.7	8.5	6.9	7.6	7.3	7.0	7.2	8.3	7.5	7.6
11	8.0	5.6	6.6	7.0	6.6	6.8	7.5	7.3	7.4	8.3	7.0	7.3
12	5.9	5.2	5.5	7.0	6.6	6.8	7.9	7.4	7.6	7.9	7.2	7.5
13	6.0	5.7	5.9	7.5	7.0	7.3	8.0	7.8	7.9	8.3	7.5	7.8
14	6.0	5.6	5.8	7.7	7.3	7.5	7.9	7.4	7.7	8.7	7.9	8.2
15	6.8	5.6	5.8	7.9	7.5	7.6	8.0	7.7	7.8	8.4	8.0	8.2
16	7.0	6.2	6.6	8.0	7.0	7.4	8.0	7.8	7.9	8.3	8.0	8.2
17	7.2	6.1	6.3	7.1	6.8	7.0	8.1	7.8	8.0	8.3	7.9	8.1
18	7.9	5.9	7.0	7.5	7.1	7.2	8.1	7.1	7.4	8.3	7.9	8.1
19	7.8	7.1	7.7	8.5	7.5	7.8	7.6	7.0	7.1	7.9	7.2	7.5
20	8.0	6.8	7.4	8.5	8.2	8.4	7.4	6.9	7.1	8.3	7.9	8.1
21	7.9	7.0	7.5	8.6	8.2	8.5	7.5	7.1	7.3	8.6	8.3	8.5
22	7.7	7.3	7.5	8.6	8.2	8.4	7.7	7.4	7.5	8.7	8.5	8.6
23	8.2	7.3	7.6	8.7	8.3	8.5	8.2	7.7	7.9	8.5	8.1	8.3
24	8.3	8.0	8.1	8.7	8.3	8.4	8.4	8.0	8.2	8.4	8.1	8.3
25	8.7	8.2	8.5	8.8	8.3	8.6	8.4	8.2	8.3	8.5	7.3	7.8
26	8.9	8.6	8.7	8.7	8.4	8.6	8.5	8.0	8.2	8.5	7.7	8.1
27	8.8	8.5	8.7	8.9	8.4	8.6	8.3	8.2	8.3	8.6	8.2	8.4
28	8.9	8.5	8.7	8.9	8.3	8.7	8.7	7.3	8.2	8.6	8.3	8.5
29	8.6	8.3	8.5	8.8	8.3	8.6	7.5	6.9	7.1	8.7	8.3	8.5
30	8.9	8.4	8.6	8.7	8.4	8.5	7.7	6.9	7.1	8.5	8.2	8.3
31	---	---	---	9.0	8.6	8.7	7.5	7.0	7.1	---	---	---
MONTH	8.9	4.6	7.0	9.3	6.6	8.2	8.9	6.9	7.8	8.7	6.6	7.9

SALT RIVER BASIN

03302000 POND CREEK NEAR LOUISVILLE, KY--Continued

WATER TEMPERATURE, DEGREES CELSIUS, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		OCTOBER			NOVEMBER			DECEMBER			JANUARY	
1	22.1	19.1	20.5	---	---	---	7.1	4.0	5.5	5.6	3.3	4.4
2	21.5	19.3	20.5	13.6	11.3	12.6	7.9	6.9	7.4	5.8	4.0	5.0
3	21.6	20.5	21.0	13.7	11.7	12.9	11.5	7.9	10.2	5.4	3.8	4.6
4	21.6	19.4	20.4	15.2	12.5	13.9	9.3	4.7	6.6	3.7	1.7	2.8
5	22.0	17.6	19.8	15.4	11.1	13.9	5.3	2.9	4.2	4.6	3.3	3.7
6	22.7	18.1	20.3	11.0	9.5	10.1	5.7	3.4	4.6	5.4	4.7	5.1
7	21.2	19.0	20.1	9.6	7.2	8.4	6.1	4.2	5.2	5.7	4.4	5.0
8	23.4	19.1	20.8	8.7	6.2	6.9	5.1	2.6	4.0	6.1	5.1	5.5
9	23.3	20.6	22.2	7.7	6.3	6.8	5.6	2.5	4.1	6.7	6.1	6.4
10	20.5	15.5	18.2	9.1	7.0	8.0	6.9	3.8	5.3	6.0	5.1	5.4
11	17.1	13.5	15.3	9.3	6.7	8.1	7.1	4.2	5.7	7.5	5.2	6.2
12	16.2	14.9	15.6	9.8	6.9	8.4	8.2	5.6	6.7	7.4	4.6	5.9
13	16.9	13.9	15.3	8.9	6.2	7.8	9.1	8.0	8.5	4.7	4.3	4.5
14	18.4	13.9	16.0	10.0	5.9	7.9	7.8	5.4	6.8	6.2	3.5	4.8
15	18.4	15.5	17.1	11.4	7.6	9.3	11.3	7.5	9.8	6.8	5.3	6.1
16	17.7	14.1	15.9	12.2	9.9	11.0	9.3	7.3	7.9	6.8	5.6	6.5
17	19.4	12.8	17.0	11.5	8.7	9.8	9.8	7.1	7.7	5.6	4.7	5.0
18	13.3	9.9	11.6	9.5	7.0	7.9	12.0	9.8	11.1	5.7	4.3	4.9
19	13.9	10.4	12.1	8.5	7.9	8.2	9.7	8.8	9.2	6.6	3.8	5.1
20	---	---	---	9.5	7.2	8.3	10.2	7.7	8.7	6.9	5.4	6.7
21	---	---	---	11.5	8.3	9.7	12.8	10.2	11.4	5.2	.9	2.4
22	---	---	---	12.4	11.5	11.9	12.0	9.2	11.1	.8	.0	.4
23	---	---	---	11.8	9.9	10.7	9.1	5.2	6.4	3.0	.0	1.2
24	---	---	---	10.5	8.1	9.4	5.1	2.4	3.3	3.0	1.6	2.2
25	---	---	---	11.9	8.8	10.2	3.3	1.5	2.5	2.8	.3	1.6
26	---	---	---	13.7	10.5	11.8	3.1	1.9	2.6	2.7	1.3	2.1
27	---	---	---	16.9	13.6	15.3	2.5	1.1	1.8	2.3	.5	1.2
28	---	---	---	16.3	10.1	13.7	4.2	1.5	3.1	3.5	1.9	2.6
29	---	---	---	10.0	6.8	8.0	10.2	3.7	6.6	6.0	3.2	4.3
30	---	---	---	6.7	4.2	5.6	11.3	6.3	9.1	6.0	4.3	5.2
31	---	---	---	---	---	---	6.2	4.1	4.8	5.2	2.4	3.9
MONTH	---	---	---	---	---	---	12.8	1.1	6.5	7.5	.0	4.2
		FEBRUARY			MARCH			APRIL			MAY	
1	6.0	2.7	4.4	10.7	8.0	9.3	16.4	11.4	13.4	22.9	19.0	20.5
2	8.0	4.8	6.3	13.6	10.7	11.9	16.7	11.4	14.0	21.2	16.0	18.8
3	9.2	5.7	7.3	12.4	6.2	9.2	16.1	12.2	14.3	21.2	17.3	19.5
4	10.5	7.1	8.5	8.7	4.7	6.4	15.1	13.2	14.0	21.5	18.8	20.2
5	10.9	9.7	10.2	10.7	5.3	7.9	19.9	13.8	16.2	21.1	17.3	19.4
6	11.0	10.2	10.6	11.0	9.5	10.2	22.6	15.8	19.0	19.0	14.6	16.4
7	10.7	8.4	9.4	10.2	6.6	8.5	22.7	18.2	20.6	20.7	12.5	16.0
8	8.4	7.3	7.8	10.2	5.9	8.0	21.9	18.5	20.4	21.0	16.4	18.6
9	8.9	6.1	7.4	10.1	5.8	7.6	21.9	18.2	20.3	20.9	13.0	16.5
10	10.2	7.1	8.6	9.9	4.5	7.1	18.8	15.3	17.1	21.0	15.4	17.8
11	8.7	5.8	7.2	10.9	6.7	8.8	18.1	13.2	15.7	23.2	18.9	20.9
12	8.7	5.5	7.2	10.1	8.0	8.8	16.9	14.4	15.5	23.8	20.6	21.8
13	9.0	7.8	8.3	9.0	7.4	8.5	17.6	14.4	15.9	24.2	20.2	21.9
14	8.9	5.5	7.5	7.5	6.5	6.9	19.4	16.7	17.8	27.7	20.7	22.6
15	5.4	1.7	3.1	10.6	4.9	7.4	21.8	16.0	19.3	25.1	19.4	22.0
16	3.5	1.1	2.1	12.5	7.2	9.6	22.3	16.5	19.3	25.9	21.4	23.8
17	4.3	3.2	3.6	11.6	9.0	10.1	24.0	14.4	20.1	28.2	23.1	25.4
18	8.7	3.6	5.8	9.9	7.7	9.2	22.0	18.5	20.3	26.9	23.7	24.9
19	9.7	8.6	9.1	12.4	6.6	9.2	19.9	15.7	17.2	23.6	21.9	22.8
20	9.8	6.0	8.6	11.8	7.9	10.4	15.6	13.4	14.3	24.6	22.2	23.1
21	9.4	6.3	8.0	17.4	11.1	13.7	13.4	12.2	12.9	26.9	22.4	24.0
22	10.4	7.2	8.9	15.5	13.4	14.5	17.5	10.9	13.9	26.1	23.7	25.1
23	9.1	5.7	7.5	16.4	13.4	14.9	17.5	13.7	15.6	26.5	23.6	24.9
24	8.5	6.0	7.4	16.0	11.6	13.9	19.2	12.6	16.1	29.5	23.9	26.5
25	7.9	5.0	7.0	17.3	11.7	14.6	17.2	14.4	15.8	29.1	25.6	27.1
26	7.1	4.2	5.5	16.8	13.8	15.4	20.9	13.9	17.0	26.4	25.1	25.8
27	7.9	4.1	5.7	17.7	15.9	16.7	20.7	18.4	19.5	25.7	22.8	24.6
28	10.1	4.0	7.1	16.9	12.8	15.2	20.2	18.6	19.4	29.5	23.8	26.3
29	---	---	---	15.9	10.6	13.6	20.6	18.5	19.6	30.6	25.7	28.0
30	---	---	---	12.9	7.7	10.2	23.9	17.7	20.6	31.2	26.9	29.1
31	---	---	---	13.9	9.3	11.5	---	---	---	32.1	27.1	29.8
MONTH	11.0	1.1	7.1	17.7	4.5	10.6	24.0	10.9	17.2	32.1	12.5	22.7

SALT RIVER BASIN

03302000 POND CREEK NEAR LOUISVILLE, KY--Continued

WATER TEMPERATURE, DEGREES CELSIUS, WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		JUNE			JULY			AUGUST			SEPTEMBER	
1	31.8	27.7	29.6	32.7	30.2	31.6	29.5	25.1	27.1	---	---	---
2	31.5	25.0	27.9	32.7	29.4	31.3	30.9	25.7	28.6	---	---	---
3	32.5	27.2	29.7	32.1	25.8	28.7	30.2	28.2	29.2	29.9	26.4	27.7
4	30.8	26.6	28.7	31.2	27.1	28.4	29.4	27.7	28.6	27.0	22.8	24.4
5	28.6	23.3	25.6	30.7	26.2	28.4	27.6	25.3	26.4	24.7	22.7	23.4
6	26.4	22.3	24.6	31.6	28.3	30.1	27.2	23.2	25.6	25.0	23.6	24.3
7	26.7	22.3	24.8	32.4	29.7	31.0	30.3	22.6	26.8	25.1	23.1	24.1
8	26.7	23.3	25.3	31.5	29.4	30.5	29.7	27.0	28.3	25.2	23.0	24.0
9	27.9	23.9	26.0	29.3	26.1	28.0	28.9	25.4	27.8	24.6	23.6	24.1
10	27.9	25.4	26.8	28.8	23.3	25.2	---	---	---	24.3	22.9	23.5
11	27.9	25.9	26.8	27.3	24.4	25.7	---	---	---	24.6	23.1	23.8
12	29.3	25.1	26.9	29.7	25.5	27.6	---	---	---	24.6	22.8	23.6
13	30.9	27.8	29.3	31.6	26.3	28.7	---	---	---	25.1	23.8	24.4
14	30.5	28.3	29.6	30.2	25.9	28.1	---	---	---	25.4	24.3	24.9
15	31.0	28.5	29.9	30.8	25.2	28.0	---	---	---	25.0	23.9	24.5
16	30.4	28.4	29.3	30.8	26.0	28.6	---	---	---	24.9	24.3	24.7
17	28.7	25.3	26.5	31.8	27.9	30.1	---	---	---	24.6	23.4	24.0
18	27.1	23.6	25.1	32.3	25.4	30.0	---	---	---	23.6	21.1	22.6
19	29.1	23.9	26.4	33.0	29.8	31.6	---	---	---	21.7	18.7	20.3
20	31.6	26.0	28.6	32.9	30.6	31.9	---	---	---	20.5	16.2	17.7
21	30.9	23.2	26.4	33.4	30.7	32.1	---	---	---	18.7	15.3	17.2
22	27.9	23.3	25.3	33.6	31.5	32.7	27.9	24.5	26.3	18.7	17.5	18.3
23	27.7	24.7	26.3	33.3	31.3	32.5	---	---	---	22.1	18.7	20.2
24	30.3	24.6	27.0	32.5	30.5	31.5	29.9	25.3	28.3	21.4	17.4	18.9
25	29.9	26.4	28.0	30.7	22.3	27.5	30.0	23.8	28.7	20.9	16.0	18.2
26	30.3	26.4	28.5	30.4	24.4	27.7	---	---	---	20.3	16.9	18.8
27	31.1	26.8	29.3	29.3	25.6	27.9	28.4	25.3	27.2	19.5	15.7	17.9
28	30.9	28.3	29.7	27.3	22.5	26.4	---	---	---	20.6	17.9	19.3
29	31.7	27.6	29.7	28.2	22.0	25.9	---	---	---	21.7	19.4	20.5
30	32.6	29.2	31.0	30.2	23.0	27.0	---	---	---	23.0	20.5	21.5
31	---	---	---	29.2	25.7	27.5	---	---	---	---	---	---
MONTH	32.6	22.3	27.6	33.6	22.0	29.1	---	---	---	---	---	---

OXYGEN DISSOLVED (MG/L), WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

		OCTOBER			NOVEMBER			DECEMBER			JANUARY	
1	9.7	7.2	8.4	---	---	---	11.5	9.6	10.5	10.9	10.3	10.7
2	9.9	7.9	9.1	11.5	8.9	10.4	11.3	9.2	10.1	10.8	10.3	10.5
3	9.9	7.4	8.7	11.5	8.7	10.1	9.2	7.2	7.7	11.0	10.4	10.7
4	9.2	4.8	6.1	11.4	8.7	10.1	9.0	7.6	8.4	11.1	10.5	10.8
5	6.2	5.1	5.6	10.9	5.9	8.0	9.8	8.7	9.2	10.8	10.1	10.4
6	6.2	4.9	5.6	9.6	4.9	6.6	9.9	8.7	9.2	10.1	9.8	10.0
7	6.2	5.1	5.6	10.8	8.0	9.1	10.0	8.8	9.3	10.2	9.6	9.9
8	6.8	5.2	5.8	11.3	9.4	10.2	10.3	9.1	9.6	9.6	9.1	9.4
9	6.6	4.6	5.4	11.3	7.3	9.4	10.5	9.5	10.0	9.0	8.6	8.8
10	5.4	4.6	4.9	8.0	7.0	7.4	10.7	9.5	10.1	8.9	8.4	8.7
11	6.2	5.4	5.7	8.9	6.9	7.7	10.9	9.4	10.1	8.7	7.9	8.4
12	6.0	5.1	5.6	9.8	7.5	8.4	10.8	9.4	10.2	8.4	7.9	8.2
13	6.1	5.3	5.6	10.3	7.8	8.8	11.3	7.9	9.5	8.5	8.1	8.3
14	6.4	5.5	5.9	10.6	7.8	9.4	12.9	9.1	10.7	8.3	7.6	8.0
15	6.9	5.5	6.1	11.3	8.1	9.7	12.8	7.8	9.1	7.5	6.7	7.1
16	7.4	5.9	6.6	10.5	8.0	9.1	9.6	8.1	8.7	7.1	6.5	6.8
17	7.6	5.2	6.7	10.8	6.9	8.4	9.3	8.6	8.9	7.7	6.7	7.1
18	8.3	5.8	6.6	11.9	8.9	9.8	8.5	8.0	8.2	7.4	6.7	7.1
19	8.4	7.1	7.8	12.0	9.1	10.3	8.8	8.1	8.5	7.1	6.4	6.8
20	---	---	---	12.1	9.0	10.2	9.1	8.5	8.8	6.8	5.3	5.9
21	---	---	---	12.4	9.9	10.9	8.5	8.0	8.2	7.0	5.6	6.1
22	---	---	---	11.8	6.0	8.2	8.7	8.1	8.4	7.0	6.2	6.7
23	---	---	---	8.5	6.0	7.1	9.8	8.7	9.5	6.8	6.1	6.4
24	---	---	---	10.0	6.9	8.1	10.7	9.7	10.2	6.6	5.4	5.9
25	---	---	---	10.7	7.5	8.8	11.0	10.3	10.6	7.8	6.2	6.7
26	---	---	---	10.1	7.5	8.6	11.1	10.4	10.7	8.4	6.5	7.3
27	---	---	---	9.7	6.8	8.2	11.1	10.6	10.8	8.6	7.6	8.0
28	---	---	---	8.7	5.8	6.7	11.1	10.6	10.8	9.2	7.9	8.4
29	---	---	---	10.4	7.0	8.3	10.7	9.2	10.2	9.7	8.2	8.8
30	---	---	---	11.1	8.9	9.9	10.4	8.6	9.6	9.3	8.4	8.8
31	---	---	---	---	---	---	10.7	9.9	10.3	11.3	9.2	10.0
MONTH	---	---	---	---	---	---	12.9	7.2	9.6	11.3	5.3	8.3

SALT RIVER BASIN

03302000 POND CREEK NEAR LOUISVILLE, KY--Continued

OXYGEN DISSOLVED (MG/L), WATER YEAR OCTOBER 1990 TO SEPTEMBER 1991

DAY	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN
		FEBRUARY			MARCH			APRIL			MAY	
1	11.6	10.0	10.7	12.9	10.8	11.9	10.4	8.5	9.4	7.0	6.0	6.4
2	12.3	10.4	11.1	12.1	9.5	10.6	12.2	8.1	9.5	7.5	5.8	6.7
3	12.8	10.7	11.7	11.9	10.0	10.9	11.1	8.1	9.7	7.3	6.0	6.7
4	13.2	11.0	11.9	12.8	11.1	11.8	10.8	7.8	8.9	6.5	4.8	5.7
5	13.0	9.8	11.3	13.2	10.6	12.0	11.1	6.9	8.7	6.5	4.8	5.5
6	10.4	9.9	10.1	11.9	8.7	9.7	11.4	7.2	9.4	6.4	4.7	5.3
7	10.9	10.0	10.4	11.2	8.7	9.7	11.1	7.0	9.0	6.8	6.1	6.5
8	11.5	10.4	10.8	11.6	9.5	10.6	9.4	6.2	7.2	6.5	4.7	5.9
9	12.1	10.7	11.3	11.2	9.5	10.4	8.0	6.0	6.8	6.3	4.7	5.9
10	12.4	10.5	11.3	12.0	9.2	10.5	9.4	6.3	7.7	7.0	5.8	6.2
11	12.7	10.7	11.6	12.3	9.3	10.8	10.5	7.5	8.8	6.9	5.1	5.7
12	13.1	10.9	11.9	11.0	8.1	9.4	9.5	7.1	8.4	6.5	4.7	5.5
13	13.1	10.2	11.0	8.2	7.7	7.9	7.7	7.0	7.3	6.0	4.7	5.3
14	11.2	10.4	10.7	8.2	7.7	7.9	9.3	6.7	7.3	7.0	4.3	5.5
15	12.5	11.2	11.7	9.5	7.8	8.5	8.7	6.6	7.6	6.1	4.7	5.4
16	12.8	11.8	12.2	9.0	6.9	7.9	8.9	6.4	7.7	6.1	5.2	5.6
17	12.5	11.3	11.7	8.6	6.5	7.2	9.0	6.9	8.0	6.1	4.6	5.2
18	11.9	10.8	11.4	7.3	6.6	6.9	8.6	6.8	7.8	5.6	4.8	5.2
19	10.9	10.6	10.7	8.4	6.6	7.3	8.3	6.3	7.0	5.7	4.2	4.7
20	11.9	10.5	11.0	8.3	6.3	7.3	8.3	7.0	7.5	5.9	5.0	5.4
21	12.0	10.6	11.3	8.7	5.8	7.0	9.2	7.6	8.3	6.3	5.2	5.6
22	12.2	10.6	11.3	6.3	5.6	6.0	9.4	8.2	8.9	6.6	4.9	5.7
23	12.8	10.9	11.7	6.8	6.0	6.4	9.3	7.6	8.4	6.2	4.8	5.5
24	13.0	11.0	11.9	7.9	6.5	7.1	9.1	6.2	7.4	6.0	5.1	5.5
25	13.3	10.9	11.9	8.5	6.5	7.3	9.6	6.9	8.0	6.0	4.7	5.3
26	14.3	11.7	12.5	7.7	6.3	6.9	9.3	7.0	8.2	5.5	3.0	3.9
27	13.8	11.7	12.6	7.5	6.3	6.9	8.8	6.5	7.3	5.2	3.7	4.6
28	13.7	11.7	12.7	8.8	6.7	7.4	7.3	5.9	6.4	5.4	3.7	4.4
29	---	---	---	8.8	6.8	7.7	6.6	5.2	5.8	5.3	3.5	4.3
30	---	---	---	10.4	8.2	8.9	7.5	5.4	6.0	5.5	3.8	4.5
31	---	---	---	10.9	8.6	9.6	---	---	---	6.5	3.6	5.0
MONTH	14.3	9.8	11.4	13.2	5.6	8.7	12.2	5.2	7.9	7.5	3.0	5.4
		JUNE			JULY			AUGUST			SEPTEMBER	
1	7.2	1.8	5.3	18.5	6.0	12.6	10.0	4.9	8.3	5.2	3.9	4.3
2	7.1	1.1	4.1	12.5	2.9	7.3	11.2	6.9	8.7	5.6	4.4	4.9
3	9.9	2.5	5.6	10.0	.7	4.5	15.1	6.3	9.8	6.0	4.4	5.0
4	12.7	2.7	7.3	10.3	2.3	5.5	12.1	6.2	8.6	6.1	4.2	5.2
5	13.7	5.0	9.2	15.0	3.8	9.0	9.3	6.1	7.6	5.6	3.9	4.6
6	13.9	6.1	9.5	14.3	4.6	9.6	9.1	5.7	7.5	5.6	4.1	4.7
7	14.2	6.1	10.2	13.9	5.2	10.2	8.7	5.5	7.2	6.0	4.5	5.2
8	13.2	5.7	9.5	12.8	4.5	8.7	8.7	5.7	7.3	6.9	5.1	5.7
9	14.3	5.0	9.7	10.4	2.9	7.0	8.7	4.2	5.9	7.0	5.0	5.9
10	14.0	4.5	9.7	8.9	2.3	4.6	5.3	3.3	4.3	8.8	4.9	6.1
11	12.6	4.0	8.3	4.1	3.5	3.9	6.3	4.1	5.1	8.8	3.7	5.9
12	14.5	4.9	9.6	4.2	3.3	3.8	7.6	4.8	6.1	9.5	4.5	6.5
13	15.1	3.7	9.8	5.4	3.8	4.6	8.3	5.8	7.0	9.5	5.0	7.2
14	13.9	3.7	9.5	6.4	4.5	5.3	8.3	5.2	6.9	9.6	5.0	7.3
15	14.2	3.4	9.0	8.0	4.7	6.1	8.8	5.6	7.3	8.5	5.4	7.2
16	13.5	3.3	8.3	8.0	1.3	4.0	8.7	6.0	7.6	8.0	5.1	6.7
17	10.8	3.1	5.5	3.3	1.4	1.8	8.3	5.6	6.9	7.5	5.2	6.4
18	6.3	3.4	4.5	5.1	1.4	2.2	7.3	3.3	5.1	7.1	5.6	6.1
19	5.6	4.2	4.8	9.9	3.9	6.2	6.8	4.1	5.0	7.8	3.3	5.2
20	6.0	4.4	5.1	10.6	5.6	8.4	6.6	3.7	5.1	10.0	6.2	7.8
21	7.1	4.4	5.5	10.2	5.7	8.4	7.4	4.6	5.9	10.7	8.1	9.2
22	6.7	5.5	6.0	10.0	5.9	8.3	7.7	5.1	6.3	10.1	7.3	8.6
23	7.1	5.6	6.2	9.5	5.8	8.2	8.1	5.2	6.6	9.3	6.8	8.3
24	8.1	6.3	6.9	9.2	6.3	8.0	8.2	5.3	7.1	9.3	6.8	7.9
25	9.2	6.4	7.4	9.1	6.4	7.8	8.3	5.3	7.0	9.5	5.2	7.2
26	10.4	6.7	8.3	10.5	6.8	8.5	8.1	4.7	6.6	9.6	6.5	8.0
27	11.4	6.7	9.2	10.4	7.2	8.8	7.7	5.3	6.5	10.3	7.3	8.7
28	11.3	7.0	9.4	8.9	7.1	8.0	7.8	3.3	6.4	9.9	7.7	8.9
29	12.7	7.1	10.0	9.4	7.5	8.4	5.3	2.2	3.2	9.4	7.7	8.7
30	20.1	7.6	12.5	10.0	7.6	9.0	5.6	2.4	3.8	8.9	7.5	8.3
31	---	---	---	9.4	8.2	8.9	5.6	3.4	4.1	---	---	---
MONTH	20.1	1.1	7.9	18.5	.7	7.0	15.1	2.2	6.5	10.7	3.3	6.7

B&V WASTE SCIENCE AND TECHNOLOGY CORP. Reference 34

TELEPHONE MEMORANDUM

USEPA Region IV
Jefferson Forest Drum Site
Flood Hazard

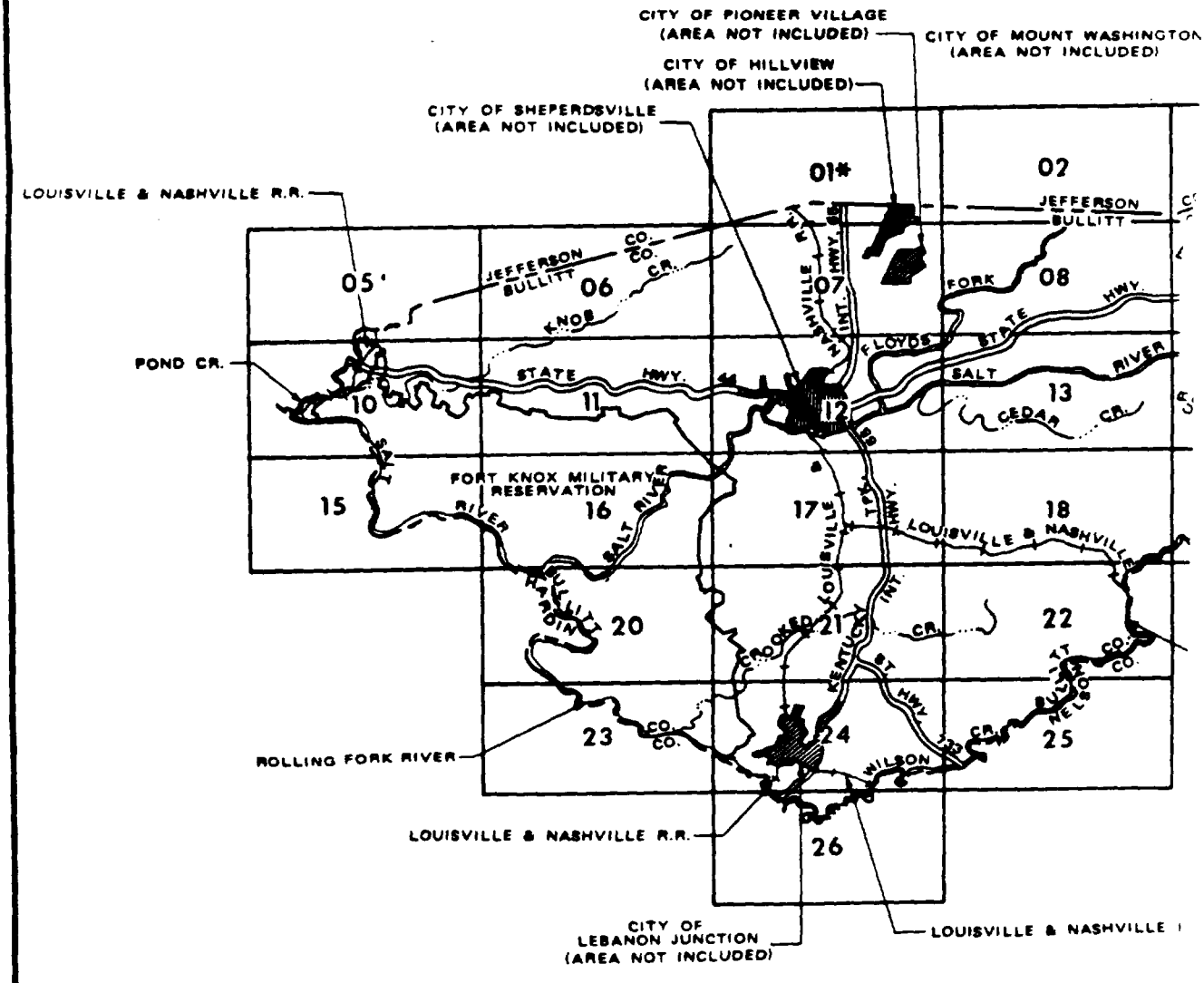
BVWST Project 52009.049
BVWST File D.2
October 5, 1993
8:15 a.m.

To: State of Kentucky Customer Service Representative
Company: FEMA
Phone No.: 404-853-4406

Recorded by: John Nett

I requested clarification on the flood hazards within an area of Bullitt County, Kentucky, (an area that includes the site) in a panel noted as "not printed". (The map index is attached to this memorandum). I was informed this means no flood insurance threat is recognized for this area. Therefore, flood insurance is not required in order to obtain a loan.

John Nett
10/5/93


CITY OF PIONEER VILLAGE
(AREA NOT INCLUDED)
CITY OF MOUNT WASHINGTON
(AREA NOT INCLUDED)
CITY OF HILLVIEW
(AREA NOT INCLUDED)
CITY OF SHEPERDSVILLE
(AREA NOT INCLUDED)
LOUISVILLE & NASHVILLE R.R.
POND CR.
ROLLING FORK RIVER
LOUISVILLE & NASHVILLE R.R.
CITY OF
LEBANON JUNCTION
(AREA NOT INCLUDED)
LOUISVILLE & NASHVILLE
FORT KNOX MILITARY
RESERVATION
JEFFERSON
BULLITT
CO.
CO.
CR.
KNOB
STATE
HWY.
44
NASHVILLE
ST.
HWY.
INT.
FLOYDS
FORK
STATE
HWY.
SALT
RIVER
CEDAR
CR.
SALT
RIVER
SALT RIVER
BULLITT
HARDIN
CO.
CO.
LOUISVILLE
TRAIL
INT.
LOUISVILLE & NASHVILLE
CROOKED
CR.
KENTUCKY
ST.
HWY.
733
WILSON
CR.
BULLITT
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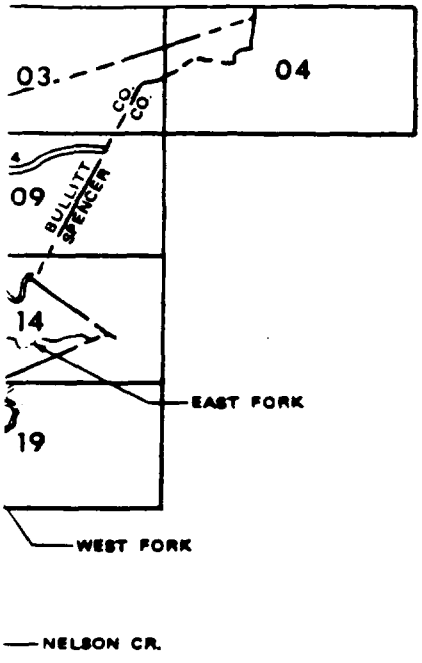
*NOT PRINTED



LEGEND

SPECIAL FLOOD HAZARD AREA — ZONE A

Note. These maps may not include all Special Flood Hazard Areas in the community. After a more detailed study, the Special Flood Hazard Areas shown on these maps may be modified, and other areas added.

CONSULT NFIA SERVICING COMPANY OR LOCAL INSURANCE AGENT OR BROKER TO DETERMINE IF PROPERTIES IN THIS COMMUNITY ARE ELIGIBLE FOR FLOOD INSURANCE.

INITIAL IDENTIFICATION DATE:
MAY 20, 1977

Converted to a Flood Insurance Rate Map By Letter Effective 07-01-91

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

FLOOD HAZARD BOUNDARY MAP N - 01-26

MAP INDEX

BULLITT CO., KY
(UNINC. AREAS)

COMMUNITY NO. 210273A

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

Reference 35

TELEPHONE MEMORANDUM

USEPA - Region IV
ARCS-Site Assessment
Ground and surface water withdrawals
in western Jefferson and Bullitt
Counties, Kentucky.

BVWST Project 52009.032
BVWST File 52009.032
March 26, 1993
9:50 a.m.

To: Dionne Fields
Company: Kentucky Division of Water Quantity
Phone No.: 502-564-3410

Recorded by: Dane G. Pehrman

Spoke with Ms. Fields regarding the presence of any water intakes and groundwater wells along the Mill Creek, Salt River, Pond Creek, and Ohio Rivers in western Jefferson and Bullitt Counties.

Kentucky does not regulate agricultural intakes. There are no surface water intakes for drinking water along the above mentioned rivers in Bullitt and Jefferson Counties. There are no surface water intakes on the Ohio River from the Louisville Water Company intakes (upstream of the site) down to at least Lock Haven, KY (the end of the surface water pathway).

She also provided me with additional information regrading industrial and commercial surface water and groundwater withdrawals. None of these withdarwals occurs within a pathway target area of Clark's Landfill.

Jim Beam Distillery has three surface water intakes in Bullitt County. One intake, drawing 2,8 million gallons/day (MGD) is located on Lake 2, 1 mile northeast of the plant on a tributary of Long Lick Creek. A second intake, drawing 0.9 MGD, is located on Lake 3, 350 feet south of Highway 245, on a tributary of Long Lick Creek. The third intake, drawing 198,000 gallons/day, is located at the plant on Long Lick Creek.

Golden Foods uses a groundwater well on 7th Street in Louisville, pumping 40,000 gallons/day from the alluvial aquifer for food processing operation.

Old Fitzgerald Distillery uses 3 groundwater wells 2,600 feet east of Cane Run Road on Tucker Ave for whisky and distilled spirit production, pumping 150,000 gallons/day from the alluvial aquifer.

Reference 36

B&V WASTE SCIENCE AND TECHNOLOGY CORP.

TELEPHONE MEMORANDUM

USEPA Region IV
Jeff. Forest Drum/Coral Ridge Market PAs
Common Names for Threatened and Endangered
Species Observed in the Brooks and Valley
Station Quadrangles

BVWST Projects 52009.049/050
BVWST File C.2
October 6, 1993
2:15 p.m.

To: Laurel McNeil
Company: Kentucky State Natures Preserves Program Comm.
Phone No.: 502-564-2886

Recorded by: John Nett

I asked Ms. McNeil if she would provide the common names for the threatened and endangered species observed in the Brooks and Valley Station quadrangles as listed in the database. The common names are as follows:

1.	*Isoetes melanopoda*	Blackfoot quillwort
2.	*Viola egglestonii*	Eggleston's violet
3.	*Sagitaria graminea (var. graminea)*	Grassleaf arrowhead
4.	*Rubus whartoniae*	Wharton's dewberry
5.	*Stellaria longifolia**	Long-leaf stitchwort
6.	*Cabomba caroliniana*	Carolina fanwort
7.	*Leavenworthia exigua (var. laciniata)*	Glade cress
8.	*Myotis septentrionalis*	Northern long-eared bat
9.	*Myotis grisescens*	Grey bat
10.	*Pleurobema clava*	Clubshell

* The long-leaf stichwort was the only threatened/endangered species listed in the database for the Valley Station quadrangle.

John Nett
10/6/93

.. MAGNUM	FREQ	EORANK	LASTOBS	EOCODE.....	SNAME:.....	LAT:...	LONG:...
1	M	E	1981-05	PDCAROXOMO*001	STELLARIA LONGIFOLIA	380706N	0854623W

Reference 37

.. MARGNUM	PREC	EORANK	LASTOBS	EOCODE.....	SNAME:.....	LAT:...	LONG:...
1	S	E	1981-05	PPISO010D0*002	ISOETES MELANOPODA	380024N	0854357W
2	M	E	1972-04	PDVIO040H0*006	VIOLA EGGLESTONII	380207N	0853821W
3	G	H	1957-00	PMALI040A0*003	SAGITTARIA GRAMINEA	380543N	0854323W
4	S	X	1967-01	AMACC01150*002	MYOTIS SEPTENTRIONALIS	380629N	0854400W
5	M	E	1984-06	PDROS1K8C0*001	RUBUS WHARTONIAE	380054N	0854223W
6	M	E	1984-06	PDROS1K8C0*002	RUBUS WHARTONIAE	380524N	0854324W
7	S	E	1981-05	PDCAR0X0M0*002	STELLARIA LONGIFOLIA	380024N	0854351W
8	M	H	1940-07	PDNYM02010*002	CABOMBA CAROLINIANA	380620N	0854343W
9	M	O	1984-02	AMACC01040*044	MYOTIS GRISESCENS	380101N	0854108W
10	S	X	1979-10	IMBIV35060*033	PLEUROBEMA CLAVA	380204N	0853934W
11	S	E	1972-04	PDBRA1L042*045	LEAVENWORTHIA EXIGUA VAR LACINIATA	380207N	0853821W
13	S	B	1990-03	PDBRA1L042*043	LEAVENWORTHIA EXIGUA VAR LACINIATA	380446N	0853841W
14	S	B	1990-03	PDBRA1L042*068	LEAVENWORTHIA EXIGUA VAR LACINIATA	380435N	0853818W
15	S	B	1990-03	PDBRA1L042*068	LEAVENWORTHIA EXIGUA VAR LACINIATA	380435N	0853818W
16	S	B	1990-03	PDBRA1L042*068	LEAVENWORTHIA EXIGUA VAR LACINIATA	380435N	0853818W
17	S	E	1986-05-14	PDBRA1L042*072	Leavenworthia exigua var laciniata	380515	853828

Reference 38

B&V WASTE SCIENCE AND TECHNOLOGY CORP.
Philadelphia Office

TELEPHONE MEMORANDUM

USEPA - Region IV
ARCS - Site Assessment
Preliminary Assessment
Clark's Landfill Site
Fisheries on Rivers in the Study Area

BVWST Project 52009.032
BVWST File 52009.032
March 24, 1993
2:30 p.m

To:	Scott Hale, Fisheries Biologist
Company:	Kentucky Department of Fish & Wildlife
Phone No.:	1-502-564-5448

Recorded by: Dane G. Pehrman

Asked Mr. Hale if the Department had any fisheries data for the Ohio River, Salt River, Pond Creek, and Mill Creek in Jefferson and Bullitt Counties.

Mr. Hale informed me that all of these rivers and creeks were fished recreationally and the Ohio River is fished recreationally and commercially. Mr. Hale stated that almost all streams with perennial flow are fished in the State.

The State does not have any annual harvest data for these rivers and creeks; however, a commercial creel survey was performed on the Ohio river in 1990. Mr. Hale is sending a copy of this survey for our use.

OVERSIZED

DOCUMENT

WASTE SCIENCE AND TECHNOLOGY CORP.

Reference 40

Owner USEPA R
Plant LEE FO
Project No 52009.C
Title WETLANDS FRONTAGE CALCULATION

Computed By J.P. NEIT
Date 10-25 19 93
Checked By
Date 19
Page 1 of 1

SCOPE DETERMINE WETLANDS INFLOW FRONTAGE ALONG SURFACE WATER TARGET DISTANCE LIMIT PATHWAY

REFERENCES US DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE, NATIONAL WETLANDS INVENTORY MAPS FOR BROOKS (1992), VALLEY STATION (1989), LOUISVILLE WEST (1989), AND KOSMOSDALE (1989)

PROCEDURE SCALE TOTAL FRONTAGE FROM MAPS

REACH: SITE TO WILSON CREEK = 0 mi

REACH: WILSON CREEK TO SOUTHERN DITCH =

7/8 mi Palustrine, forested broad-leaved deciduous, temporarily flooded wetland -and- 200 ft Palustrine, emergent, persistent, seasonally flooded wetland

REACH: SOUTHERN DITCH TO POND CREEK =

1-1/3 mi man-modified unclassified wetlands -and- 3/8 mi Palustrine, forested broad-leaved deciduous, temporarily and seasonally flooded wetland

REACH: POND CREEK TO END OF SURFACE WATER PATHWAY =

1-1/4 mi Palustrine, ~~forested~~ broad-leaved ~~deciduous~~, ~~temporarily~~ flooded and emergent, ~~persistent~~, seasonally flooded wetland

DO NOT WRITE IN THIS SPACE

P-GN-173A

REVISED, SUPERSEDED, AND VOID CALCULATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE RESPONSIBLE INDIVIDUAL

APPENDIX A

Photographic Log

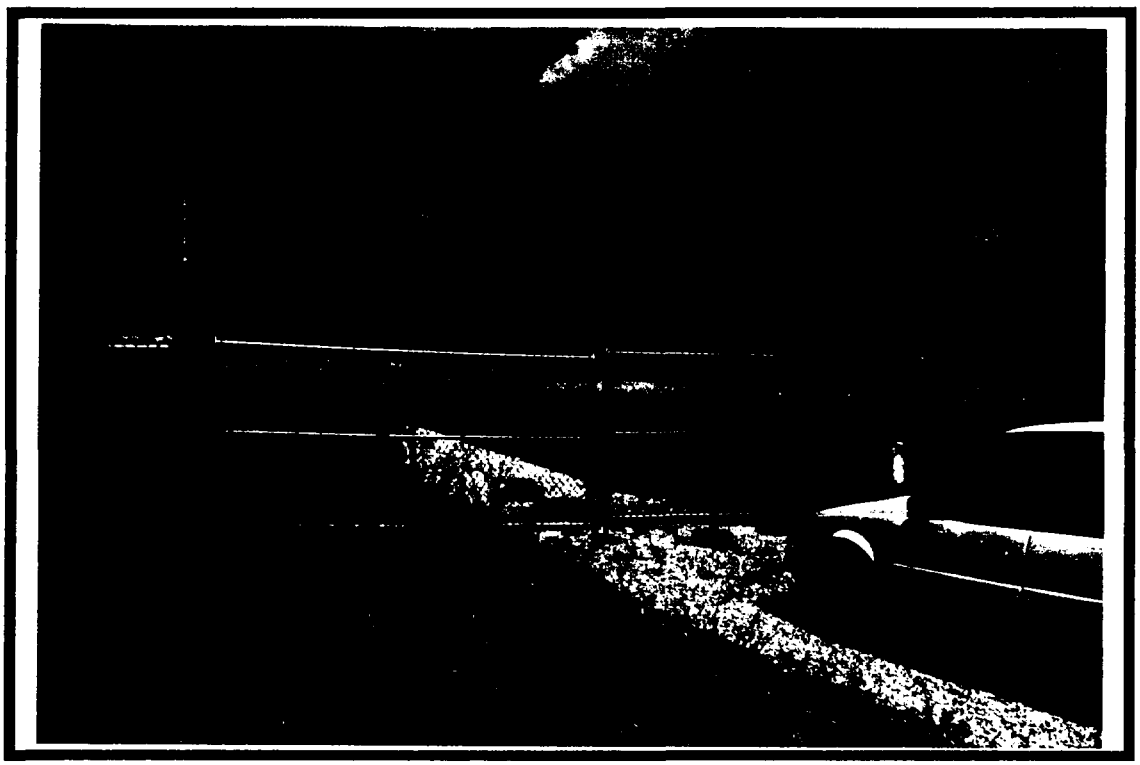


Photo-1, Roll-7184, View-NW, Taken by-JPN: View of gate at south end of access road to A.L. Taylor site. Note: Peripheral site drainage flows from left to right in the photo through culvert underlying roadbed.

Photo-2, Roll No-7184, View-SE, Taken by-JPN: View of the access road from Letts Road leading to the A.L. Taylor site. Note: Surface runoff flows from right through culvert underlying roadbed to pond at left.

Photo-3, Roll No-7184, View-NE, Taken by-JPN: View of the pond south of the A.L. Taylor site. Note: Flow from the culvert in the photo foreground feeds the pond.

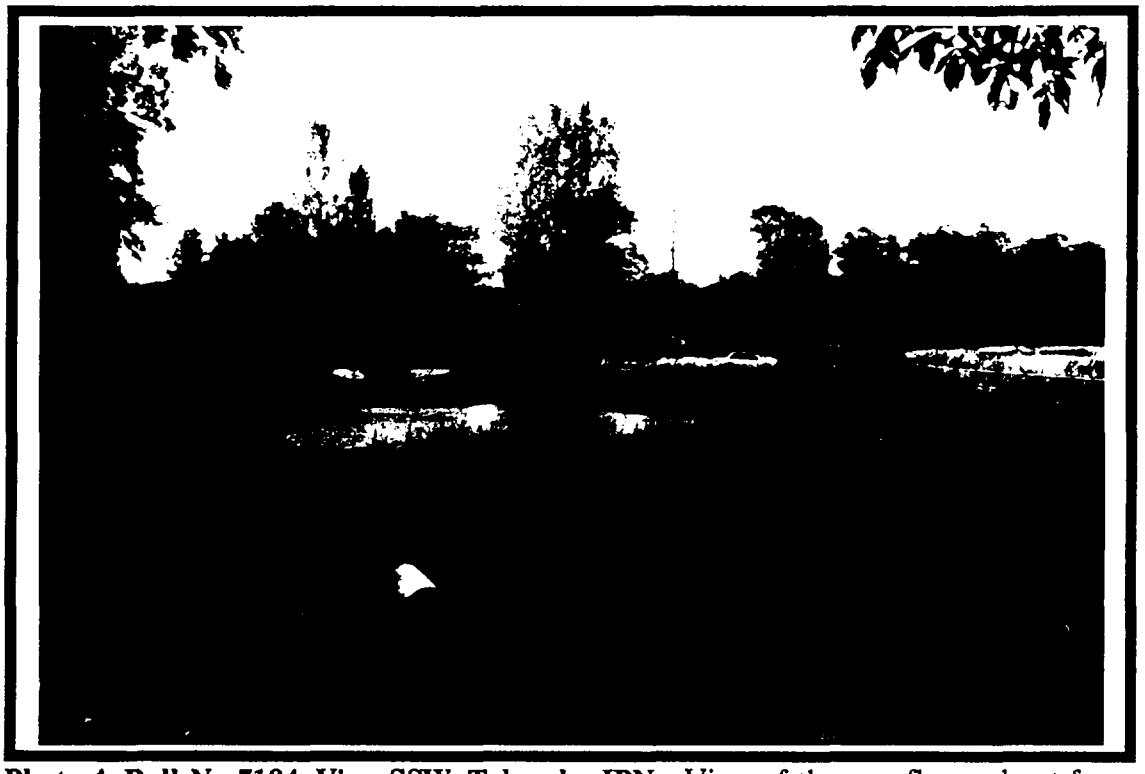


Photo-4, Roll No-7184, View-SSW, Taken by-JPN: View of the overflow culvert from the pond south of the A.L. Taylor site. Note: Pond overflow feeds Wilson Creek to the northeast.

Photo-5, Roll No-7184, View-S, Taken by-JPN: View of the Cox residence located on Letts Road. Note: The Rutledge and Bailey residences are located at the left in the photo.

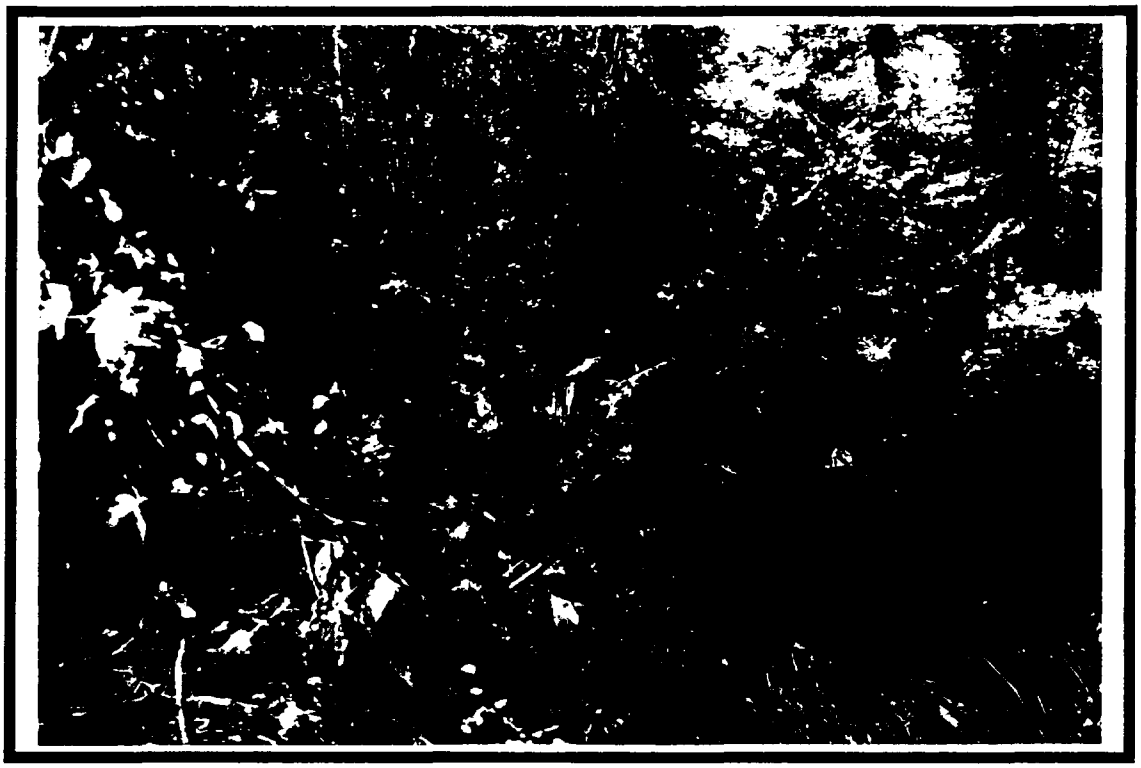


Photo-6, Roll No-7184, View-WSW, Taken by-JPN: View from the top of the soil embankment near previous drum excavation area.

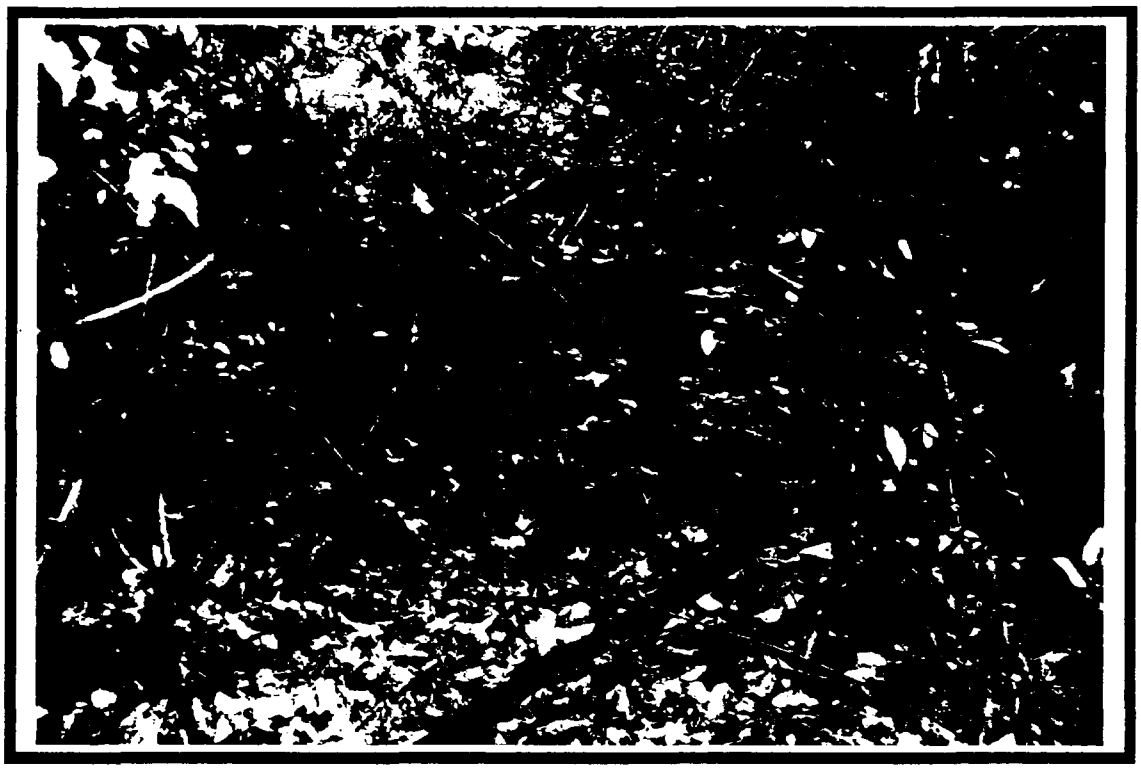


Photo-7, Roll No-7184, View-NE, Taken by-JPN: View of a corroded drum carcass and insulation-type material at the bottom of the soil embankment.

Photo-8, Roll No-7184, View-NE, Taken by-JPN: View of drum carcasses and scrap metal present in the soil embankment.

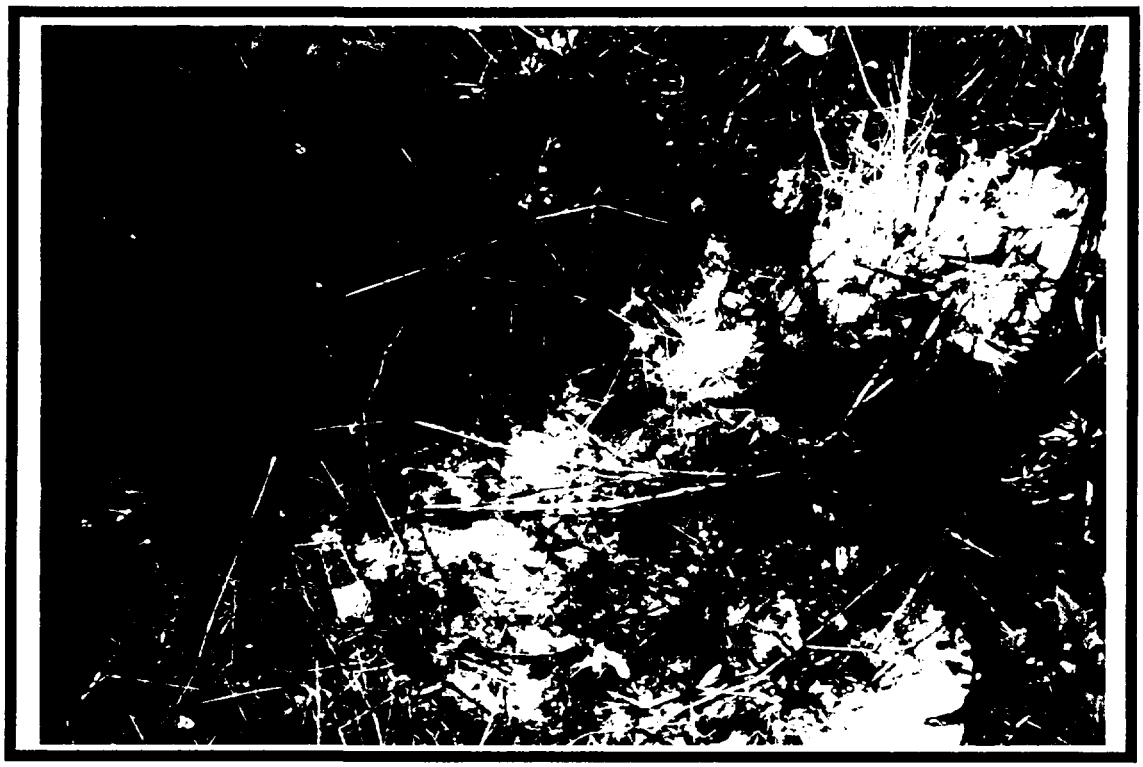


Photo-9, Roll No-7184, View-WNW, Taken by-JPN: Solidified waste material present at the base of the soil embankment.

Photo-10, Roll No-7184, View-NE, Taken by-JPN: Debris present at the base of the soil embankment. Note: An amber glass vial is present (near top center of photo).

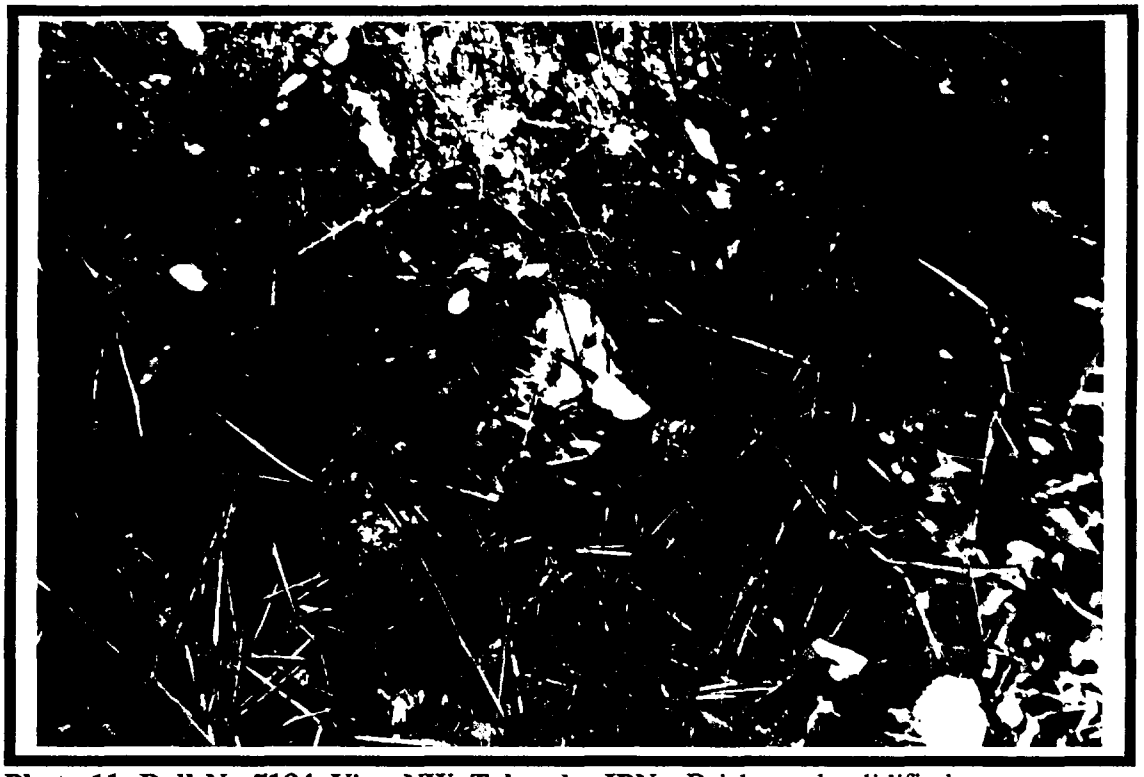


Photo-11, Roll No-7184, View-NW, Taken by-JPN: Bricks and solidified waste material present at the base of the soil embankment.

Photo-12, Roll No-7184, View-NW, Taken by-JPN: Corroded 5-gallon container present at the base of the soil embankment.

Photo-13, Roll No-7184, View-NE, Taken by-JPN: Drum carcasses, scrap metal, and solidified waste material present within the soil embankment.

Photo-14, Roll No-7184, View-NE, Taken by-JPN: Drum carcasses, scrap metal, and solidified waste material present within the soil embankment.

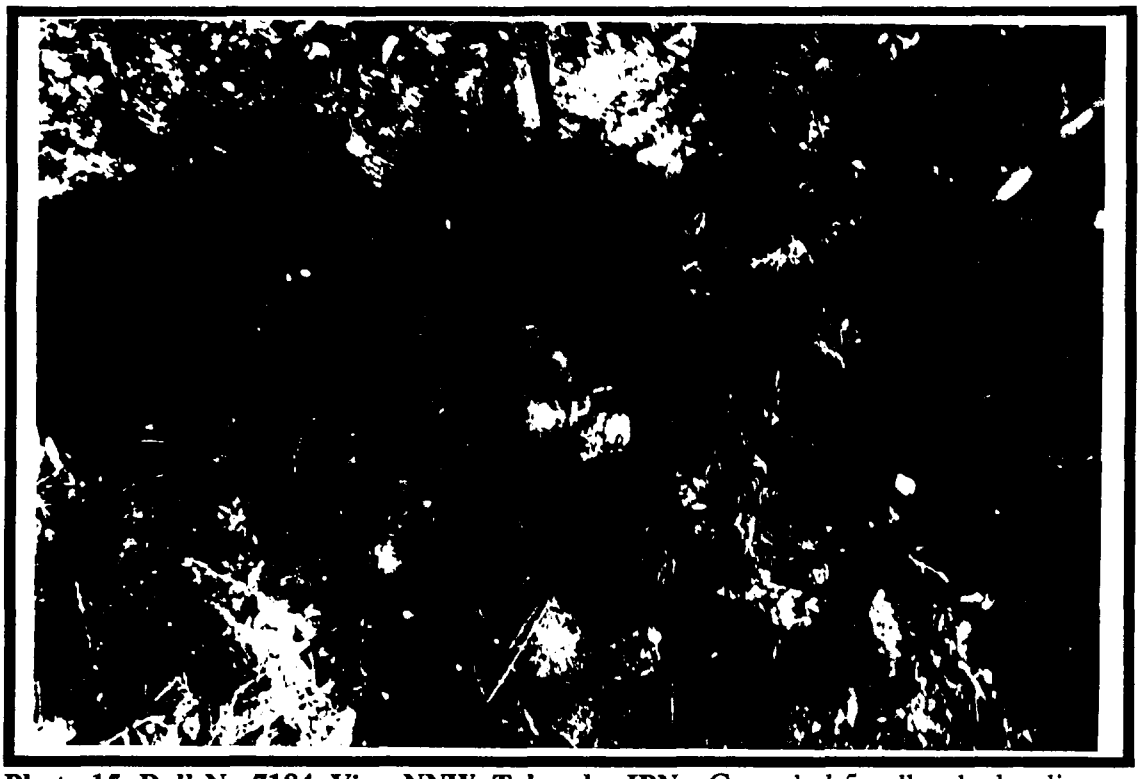


Photo-15, Roll No-7184, View-NNW, Taken by-JPN: Corroded 5-gallon hydraulic fluid container (empty). Note: This container was found approximately 80 yards northeast of the previous drum excavation area.

Photo-16, Roll No-7184, View-WSW, Taken by-JPN: View of a barren soil area located downgradient (northeast) of the previous drum excavation area (soil embankment).

Photo-17, Roll No-7184, View-NNE, Taken by-JPN: View of an old fence line running east-northeast in the photo background. Note: This fence functions as a delineation line rather than an access restriction.

Photo-18, Roll No-7184, View-W, Taken by-JPN: View of the trail that leads into the area of previous drum excavation activities (soil embankment).

Photo-19, Roll No-7184, View-NNW, Taken by-JPN: View along the LG&E maintenance road. Note: Access to the trail that leads into the area of previous drum excavation activities is located near the second power pole in this photo.

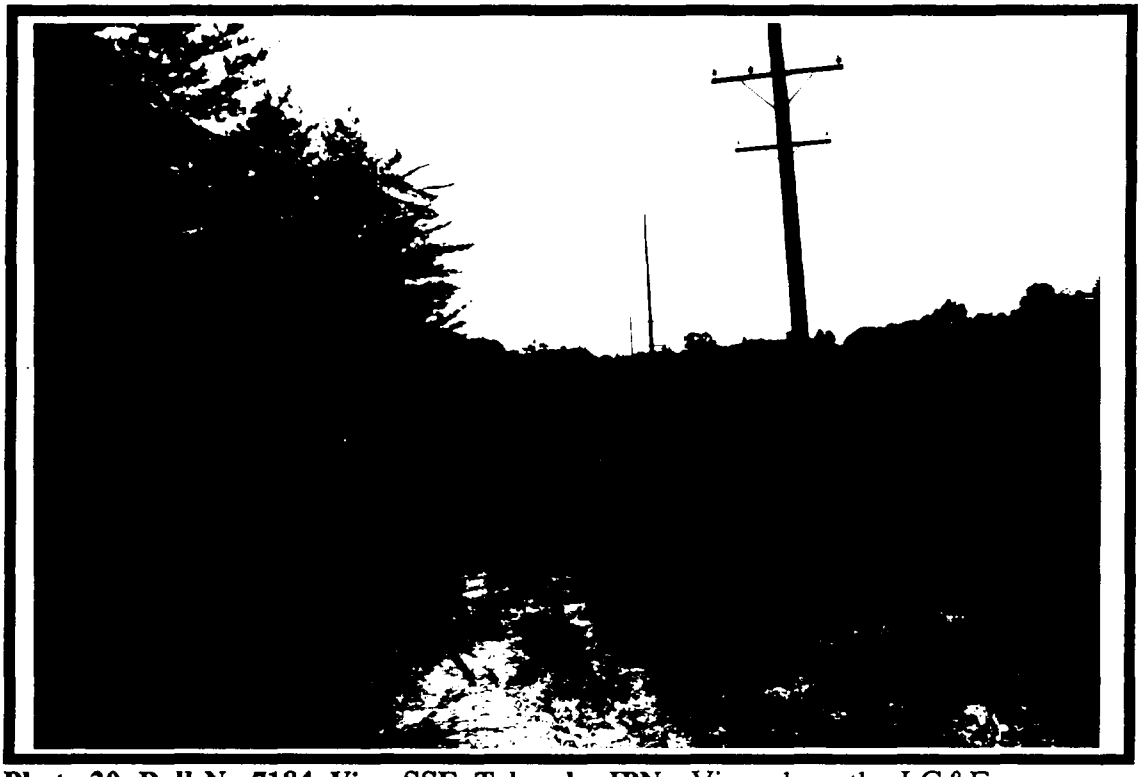


Photo-20, Roll No-7184, View-SSE, Taken by-JPN: View along the LG&E maintenance road north of the A.L. Taylor site. Note: The north gate to the A.L. Taylor site is in the center background of this photo.