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OFFICE OF ENFORCEMENT

EPA-330/2-77-016

Impact of Creosote Deposits in the Little Menomonee River, Wisconsin

(APRIL 1977)

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER

DENVER, COLORADO

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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I. INTRODUCTION

Early in 1971 a group of environmentalists in Milwaukee, Wisconsin organized a group called the Scientific Committee of the Citizens for Menomonee River Restoration (CMRR) to spearhead a cleanup project on the Menomonee River which flows through metropolitan Milwaukee. Within four months, June 1971, field action was underway. Headquarters for the project was set up in a park overlooking a section of the Menomonee River. Biologists, engineers, and chemists were among the group leaders assigned to supervise the river cleanup activities, and volunteers from schools and youth groups in the greater Milwaukee area participated. Supervising adults held special briefings to inform the young people about river areas to be cleaned and health hazards that might be encountered.

By coincidence, another youth group working without adult supervision endeavored on June 5, 1971 to clean up a branch of the river system known as the Little Menomonee River. These youngsters encountered a sticky, oily, black substance in the river bottom muds which caused chemical burns to exposed skin areas. Some of the youngsters received first aid and others were hospitalized with swelling, painful burns and related systemic effects.[1]

Lawmakers and other public officials were notified of the incident by the CMRR, and the hazardous area was posted with appropriate warning signs. The incident was brought to the attention of the Environmental Protection Agency (EPA) which, after investigating, found the hazardous material to be creosote. Subsequently, the EPA filed a suit against the Kerr-McGee Chemical Corporation for discharging creosote wastes into the Little Menomonee River.

On March 31, 1977 the Enforcement Director of EPA, Region V, requested technical assistance from EPA's National Enforcement Investigations Center (NEIC) in determining the current environmental quality of the Little Menomonee River. Specific study objectives were to:

1. Determine the approximate amount and general location of creosote deposits in the Little Menomonee River.

2. Evaluate the effects of creosote deposition on the quality of natural sediments, flowing water and aquatic biota in the river.

A field survey was performed by the NEIC in April, 1977; methods and procedures used in the study were those published as standarized methods[2,3,4] or developed and routinely used by the NEIC.

II. SUMMARY AND CONCLUSIONS

1. A ten-day investigation of the Little Menomonee River near Milwaukee, Wisconsin, was performed from April 18 to 27, 1977. The purpose of the study was to determine the presence of creosote deposits in the river and the ecological degradation caused by them.

2. Thirty-eight sampling stations were established in the lower 12.8 km (8 mi) of the river; from these, 60 water and 59 sediment samples were collected for chemical analyses. Eight of these stations in the Little Menomonee River and two in the Menomonee River were selected for intensive physical, chemical and biological study.

3. No creosote deposits were detected in sediments collected from the one-mile river reach upstream of the abandoned Kerr-McGee creosoting plant site. From the abandoned plant site to the confluence with the Menomonee River, the sediments of the Little Menomonee River contained unevenly distributed deposits of creosote. From the Kerr-McGee site to a wooden bridge approximately 1.1 km (0.7 mi) downstream, the creosote-bearing sediments averaged 6 to 10 cm thick with creosote concentrations as high as 13.5 g/kg. From the wooden bridge to Leon Terrace (2.5 mi downstream) the creosote-contaminated sediments measured 45 cm or more in thickness and detectable concentrations ranged from 1.5 to 40.0 g/kg. The highest creosote concentration of 40.0 g/kg was found in a 65 cm core of river mud collected near the Leon Terrace Bridge. Minor creosote deposits were evident in river muds of the lower 4.2 km (2.6 mi) of the Little Menomonee River.

4. Creosote concentrations from 1.5 to 40.0 g/kg in the river mud appeared to adversely affect certain communities of aquatic plants and animals. In the stream reach where creosote-bearing sediments were present, rooted aquatic plants were found least often and the variety of burrowing and bottom-dwelling invertebrates was reduced by about 50%.

5. Creosote deposits did not appear to affect water quality, algae, or fish. Apparently, the stream bed had a sufficient overburden of clean (no creosote contamination) silt, sand, and detritus to isolate the overlying aquatic habitats from the creosote-contaminated sediments.

III. HISTORICAL OVERVIEW

CHRONOLOGY OF THE KERR-MCGEE CREOSOTE PLANT AND ASSOCIATED ENVIRONMENTAL PROBLEMS

In 1921 the T. J. Moss Tie Company established a wood-preserving plant at a 36-ha (88-acre) site along the western bank of the Little Menomonee River (mile 5.8*). This plant preserved wooden railroad ties, poles, and fence posts with creosote.** Briefly, creosote processing consisted of impregnating the wood products with a mixture of equal parts of #6 fuel oil and creosote. Impregnation was done at a pressure of about 12.7 kg/cm^2 (180 psi) and a temperature of 93.3°C (200°F).[5] Initially, wastewater disposal facilities at the creosote plant consisted of a series of ditches which collected spilled oil, creosote and rain or snowmelt runoff, and discharged them to the Little Menomonee River. Sanitary wastes were discharged into septic tanks with subsurface drain fields. Creosote-treated railroad ties were stored in several areas within the plant yard, including along the river bank.[5]

Prior to 1941, the system of ditches was modified by the construction of a series of 8 ponds and an oil separator system. Wastes from the creosote processing were collected by tile drains and discharged into the oil separator basin. A series of 6 over-and-under baffles served to skim off oil and scums from wastewater prior to discharge into settling ponds. Each of the 8 ponds was about 4.5 m (15 ft) wide and 12 to 18 m (40 to 60 ft) long with an average depth of 1.8 m (6 ft). The ponds were interconnected with subsurface pipe. The last in the series of ponds was ditched directly to the Little Menomonee River.[5]

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* *As measured from the mouth of the Little Menomonee River.*

** *A mixture of 200 or more chemical compounds derived from coal tar; the majority are polynuclear aromatic hydrocarbons.*

In 1952, the T. J. Moss Tie Company surfaced about 12 of the 36 ha (30 of the 88 acres) of the plant yard and installed tile drains and slit trenches to collect rain and snowmelt runoff. About 8 ha (20 acres) were covered with 15 to 20 cm (6 to 8 in) of gravel. These areas were used to store untreated lumber, mostly railroad ties. Creosote-treated ties were stored on 4 ha (10 acres) covered with 15 to 20 cm (6 to 8 in) of cinders. The subsurface tile drain system extended under the newly surfaced yard and emptied into an open ditch. The ditch paralleled the railroad tracks north of the Company property line for several hundred feet to its junction with the Little Menomonee River.[5]

In June 1954, a Public Health Engineer with the City of Milwaukee, inspected the creosote treatment facilities at the T. J. Moss Tie Company. He found the creosote plant disposal facility to be inadequate. Subsequently, the City of Milwaukee requested the Company to install a filtering system. The recommended system consisted of straw filters (bundles of straw), placed at the lower end of the settling pond system. It was felt that these straw filters would serve to collect floating oil slicks and scum before the effluent was discharged into the Little Menomonee River. The T. J. Moss Tie Company complied.[6]

In 1963, the Kerr-McGee Chemical Corporation purchased the T. J. Moss Tie Company. The following year Kerr-McGee purchased American Creosote Company. In 1965, the two companies were consolidated and the facility at Milwaukee became known as the Moss American Company, Inc. From 1954 to 1965, there were no major changes in the treatment facilities at this creosote processing plant.[5]

In August 1966, the Moss American Company was advised by the Milwaukee Sewage Commission that the creosote plant disposal facility was not satisfactory.[7] It was alleged that oil was leaking through the wall of the waste treatment pond nearest the Little Menomonee River. The Milwaukee Sewage Commission recommended that the pond be dredged and the wall nearest the stream be rebuilt using clean clay (free of creosote). The Moss American Company complied.

Several months later a building materials dump, about 3 km (1.8 mi) upstream of the Moss American Company plant, caught fire. The dump burned out of control for 15 to 18 months, and millions of gallons of water were poured onto the fire. Runoff from the dump caused the Little Menomonee River to become anaerobic for several miles downstream.[8] Much public attention was directed toward the situation. State, county and city regulatory agencies subsequently conducted water quality surveys in the river. During these investigations, the Moss American Company effluent was also evaluated. It was found that the treatment system at Moss American was inadequate and that the effluent discharged into the river was of an undesirable quality. The City of Milwaukee advised the Moss American Company of this situation and ordered a cleanup.[9] To comply with this order, the Company installed a series of coke filters to pretreat wastes. In April 1971, all the pretreated industrial and domestic wastes from Moss American Company were diverted into the Milwaukee Metropolitan sewerage system for final treatment.[5] Two months later, the following incident occurred in the Little Menomonee River which brought State and national attention to the Moss American Company.

On June 5, 1971, several youngsters embarked on a campaign to clean up a portion of the Little Menomonee River in Milwaukee County. In the process of retrieving debris from the river bed, 23 youngsters sustained what appeared to be chemical burns to exposed skin areas. Affected arm and leg areas were coated with a dark-colored, oily substance which was also observed floating on the water and seeping up from the river sediments. Nine of the youngsters required extensive first-aid treatment. One child required hospitalization for systemic effects. Another required outpatient care for tissue swelling and painful burns. City, county and state officials conducted an investigation of the incident, which took place approximately 5.6 km (3.5 mi) downstream from the Moss American discharge. Water and sediment samples from the incident site were collected and sent to private and government laboratories for analyses. The black, oily substance which appeared to cause the chemical burns on the youngsters' skin was identified tentatively as creosote. The Moss American Company was notified of this incident.

Moss American representatives stated that their Company had not discharged any liquid wastes to the Little Menomonee since April 1971, when all wastewaters were diverted to the Milwaukee Sewage Treatment System. However, the Company took immediate steps to correct conditions at the plant site. The 8 ponds that previously served as settling basins for treatment of oil and creosote-contaminated waters were dredged and filled with uncontaminated soils. The creosote-contaminated sediments from the ponds were hauled to a sanitary landfill or adjacent Moss American property for final disposal. The pipe that led from the final pond directly to the Little Menomonee River was removed, and the bank was reinforced with uncontaminated soil.

A group of local citizens organized a committee called the Scientific Committee of the Citizens for Menomonee River Restoration, Inc. This Committee was organized to bring to the attention of city, county and state officials the indiscriminant discharge of harmful industrial wastes into the Little Menomonee River. The Committee emphasized that the Little Menomonee was a parkland waterway transversing a highly populated area. They prepared a technical paper[1] which described the injuries to local youths who worked in the river on June 5, 1971. As a result of community pressures, the Milwaukee Park Commission posted the river with signs that read DANGER - POLLUTED WATER.

In the wake of this public attention, the Moss American Company dredged 520 m (1,700 ft) of the Little Menomonee River adjacent to their property and trucked the collected sediments to a local sanitary landfill for disposal. The Company also dug a slit trench along the bank between their yard and the river and filled the trench with 3.6 m (12 ft) of clean clay to form a curtain.

Parents of the youths involved in the incident on June 5 filed suit against the Moss American Company. Apparently all suits were settled out of court. The Scientific Committee of the Citizens for the Menomonee River Restoration requested that Wisconsin Congressman Henry S. Reuss investigate the Little Menomonee River problem. Congressman Reuss complied and a professional environmental survey was made of the area. The survey report stated that significant amounts of creosote were present in the Little Menomonee River. The citizen's group then petitioned the Environmental Protection Agency for help in funding a pilot project designed to remove residual creosote and oils from the river.

In 1972, the EPA awarded two contracts for demonstration of removal and treatment of creosote-contaminated river bottom muds. Each contractor was assigned a 180 m (500 ft) segment of the creosote-contaminated river. Within this river stretch, the contractor set up a small scale feasibility demonstration using radically different removal devices. One method proved more satisfactory in removing creosote. This contractor was awarded additional money by the EPA and agreed to remove creosote from a segment of the Little Menomonee River beginning at Brown Deer Road (mile 5.9) and extending 4 km (2.5 mi) downstream. The contract extension called for a cleanup which would reduce concentrations of creosote in stream sediments to environmentally safe levels. These special projects resulted in a partial cleanup of about 1,200 m (4,000 ft) of the Little Menomonee River. They ended in November 1973 when the $320,000 in EPA funds was exhausted.[10]

In 1974, the Moss American Company's name was changed to the Kerr-McGee Chemical Corporation-Forest Products Division. Later that year the EPA filed an enforcement action against the Kerr-McGee Chemical Corporation. The action was filed pursuant to: Refuse Act of 1899, Federal Water Pollution Control Act of 1972 (FWPCA), and nuisance theory. Relief sought by the USEPA included reimbursement for the experimental projects, actual damages to the river and an injunction to force Kerr-McGee to cleanup the river, as well as civil penalties for discharge after the passage of FWPCA.

In June 1976, the Kerr-McGee plant in Milwaukee ceased operation. During the next several months (July through October 1976) treated railroad ties were removed and buildings and equipment partially dismantled. The Kerr-McGee Chemical Corporation filed a motion to dismiss the EPA action. The motion was denied and the U. S. Attorney requested the EPA Region V to finalize preparation for the pending litigations against Kerr-McGee. Based on the foregoing, EPA Region V requested that NEIC conduct the investigations described in this document.

IV. DESCRIPTION OF STUDY AREA

The Little Menomonee River has a drainage basin of about 32 km (20 mi).[11] The river originates in central Ozaukee County, Wisconsin and flows approximately 9.6 km (6 mi) south before entering Milwaukee County. From this point, it meanders an additional 11.2 km (7 mi) to join the Menomonee River which flows southeasterly through metropolitan Milwaukee and discharges into Lake Michigan [Figure 1]. The stream is fed by a number of springs in Ozaukee County and by one major tributary, Little Menomonee Creek. In its entire reach, the Little Menomonee River occupies a distinct and limited flood plain. A few marsh-like zones are found adjacent to the stream near the Ozaukee and Milwaukee County line.

The banks of the river are low, gently sloping, and generally covered with heavy foliage. Several reaches of the stream are partially obstructed by trees, decaying vegetation and debris which has fallen or been discarded into the river.

Major land use within the Little Menomonee River watershed includes 48% agricultural, 13% woodland, and 10% industrial. The remainder is used for recreational parkland and residences.[1] The rural to urban land use transition is occurring in a southerly direction. Land adjacent to the lower reach of the river has been designated for park and recreational use by the Milwaukee County Park District.[12,13] Some areas have been cleared and improved with shrubbery, plantings and paved bicycle paths.

Throughout its reach, the Little Menomonee River varies in width from about 1.5 to 12 m (5 to 40 ft). River depth varies from a few inches to approximately 1.2 m (4 ft). The average slope of the river is estimated to be 1 m/km (3.5 ft/mi).[12] The river bed is comprised

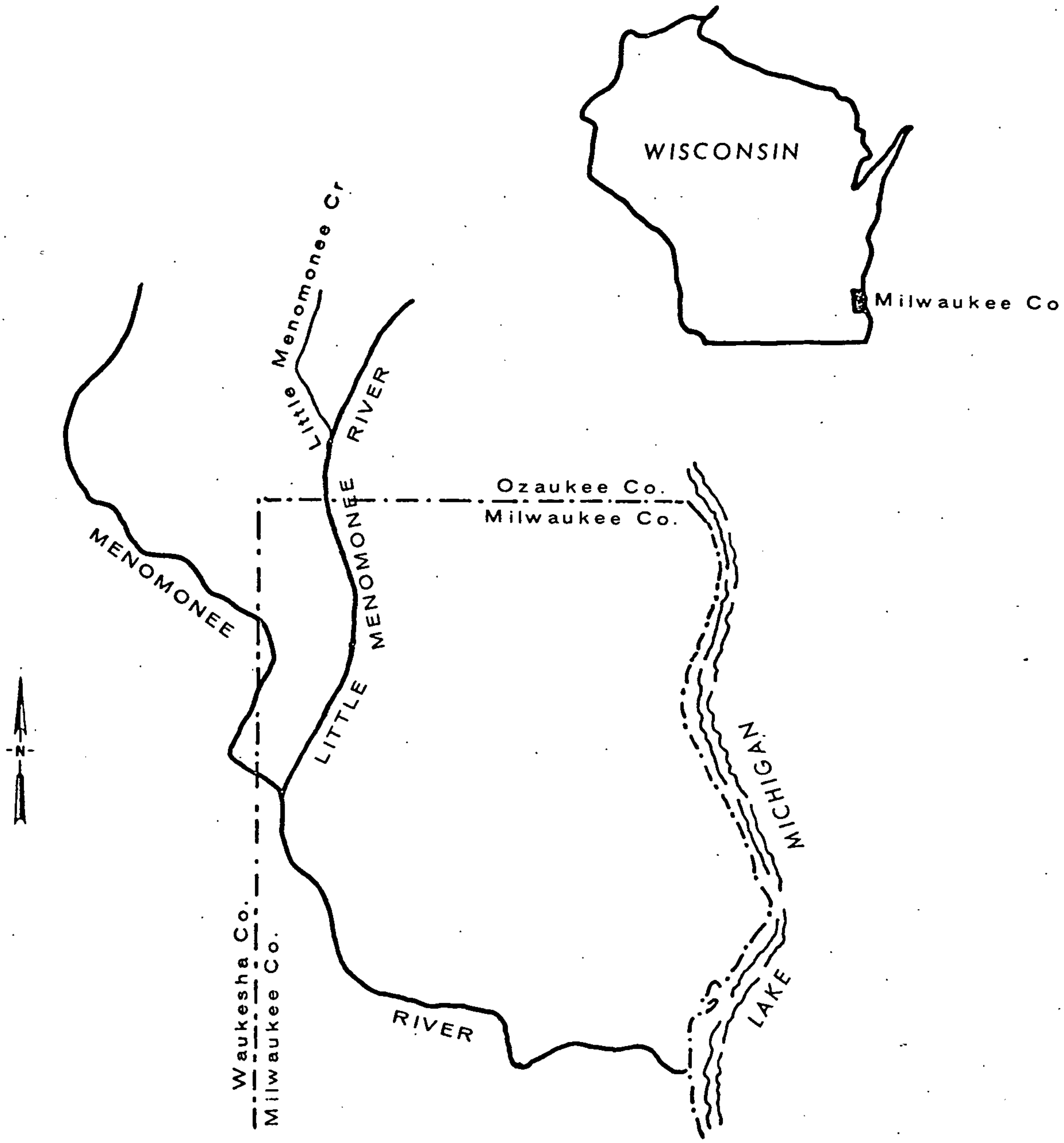

Figure 1. Little Menomonee and Menomonee Rivers Milwaukee County, Wisconsin

of rock, coarse to fine gravel, silt, and in many places, leaf detritus. During storm runoff the sediment load carried by the stream is high. Erosion problems, however, have been minimized by a large amount of adjacent woodland cover as landscaping. Along the river course there are 18 bridges and culverts. Major channelization has been done on 0.5 km (0.31 mi) of the Little Menomonee while minor channelization exists along 14.9 km (9.31 mi).[12,13]

Flow records for the Little Menomonee River are available from two gaging stations: US Geological Survey (USGS) recording gages at Donges Bay Road in Ozaukee County (mile 7.9), and in Milwaukee County, near Appleton Road (mile 1.5). For the composited 19 years of records (1958 to 1977), flow extremes at Donges Bay Road ranged from nearly no flow at times to 612 m^3/min (360 cfs) during a runoff event on April 21, 1973. The record from the gage in Milwaukee County showed the average discharge was 17.4 cfs during the period November 1974 through September 1976.[11]

Records of suspended sediment concentrations at the two USGS gaging stations indicate a rapid stream response to rainfall or snowmelt events. Sediment concentrations during base flow conditions were 30 mg/l or less, but rose rapidly to concentrations as high as 500 mg/l during high flows.

SAMPLING SITES

The comprehensive study of the Little Menomonee River was limited to the lower 11.2 km (7 mi) reach, between the Milwaukee County line and the confluence of the Little Menomonee and Menomonee Rivers near Hampton Road [Figure 2]. A team of biologists traveled the study reach in a small boat to inspect the river, and to select areas with comparable habitats for intensive ecological investigation. During the float trip, the team collected river sediment samples; each sample was examined

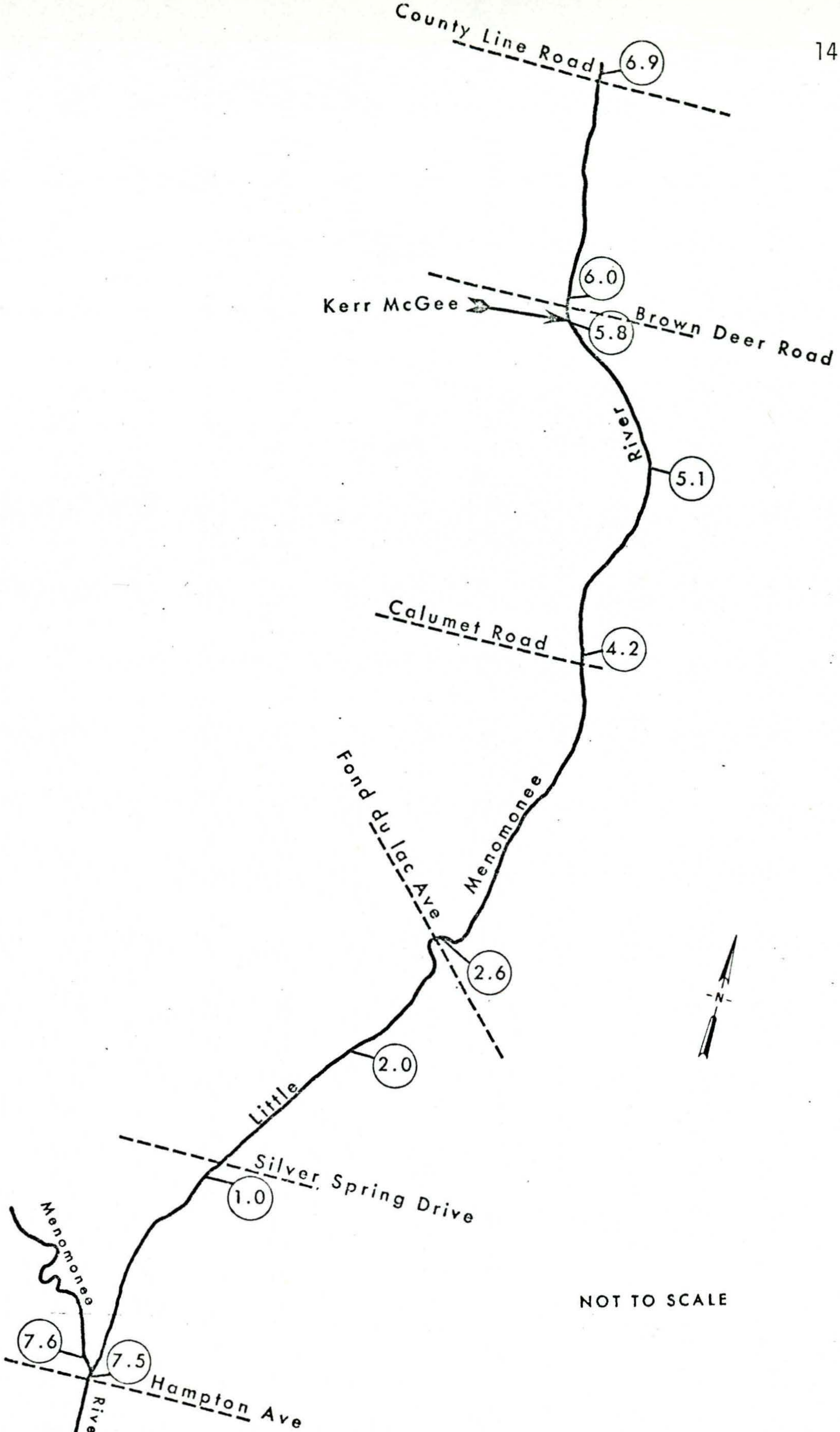

Figure 2. Intensive Sampling Sites

and a record was made of sediment characteristics. Also, areas of obvious sedimentation, general stream contours, river-bed stability and locations of deposits of creosote-like material were recorded. With this information, ten sites were selected for intensive study.

Each of the ten sampling sites consisted of approximately a 10-m long, cross-section of the river. Six transects were established at each site. At intervals along each transect line, soundings were made for water depth and the depth of the soft sediment bed. Additionally, water quality samples and biota were collected at each site; methods and chain-of-custody procedures are described in Appendices A and D of this report, respectively. Areas selected for intensive study are described below. Except as indicated, river miles are measured from the mouth of the Little Menomonee River.

Little Menomonee River - Mile 6.9

This sampling site was selected to serve as a reference station. It was located in Ozaukee County, approximately 100 m upstream of the Milwaukee County line. This reach was upstream of all known sources of industrial waste discharge (oil storage yards of Union 76; Clark Oil; Center Fuel and Quick Flash Heating Oils; and Kerr-McGee Chemical Corporation).

The river channel was nearly straight in this reach with an average width of 6.0 m. Mid-channel depth was approximately 30 cm [Figure 3]. The upstream limit of the study site was marked by a small riffle area which traversed a portion of the stream; its downstream portion was a shallow pool.

The wooded area that bordered the river, 100 m upstream of the sampling site, gave way to a shoreline cover of shrubs and grasses

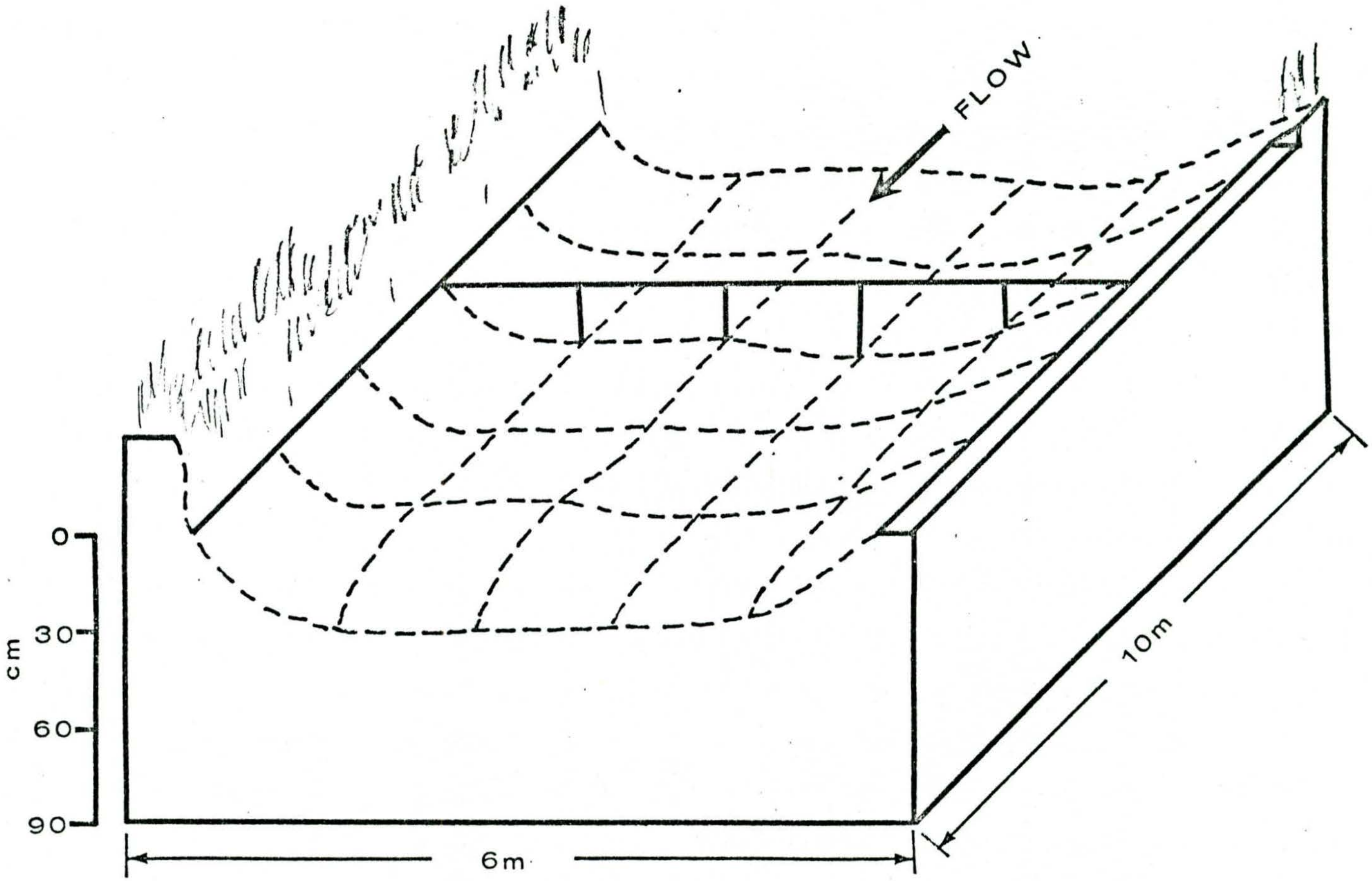

Figure 3. Bottom Topography - Mile 6.9

Little Menomonee River

interspersed with clumps of willows at the study site. The stream bottom consisted of coarse sand and clay with an overburden of fine sand, silt and vegetative detritus. In the pool area, approximately 50 cm of silt and vegetative detritus had accumulated over the harder substrate.

Little Menomonee River - Mile 6.0

This site was selected to evaluate the impact of periodic runoff discharges from the oil storage yards into the river. It was located in Milwaukee County approximately 100 m upstream from the Brown Deer Road bridge crossing.

River banks were poorly defined and covered with large stands of cattails and a few scattered clumps of willows. The stream bottom consisted of muck, silt and vegetative detritus [Figure 4].

Little Menomonee River - Mile 5.8 to 1.0

Six sampling sites were selected in this reach to determine the profile of creosote-like deposits in the river, and to show changes in the existing types of aquatic life present.

These intensive study sites were established at approximately river mile 5.8, 5.1, 4.2, 2.6 and 2.0, and 1.0.

Downstream from the mile 6.0 sampling site, the Little Menomonee River was restricted to a narrow channel (1.5 m wide), which passed under Brown Deer Road and the Chicago and Northwestern Railroad Bridges. Along the west bank, downstream from the railroad bridge, a small storm drainage ditch joined the river. From this point, the Little Menomonee bent southeast as it channeled through the abandoned Kerr-McGee creosoting plant property [Figure 2].

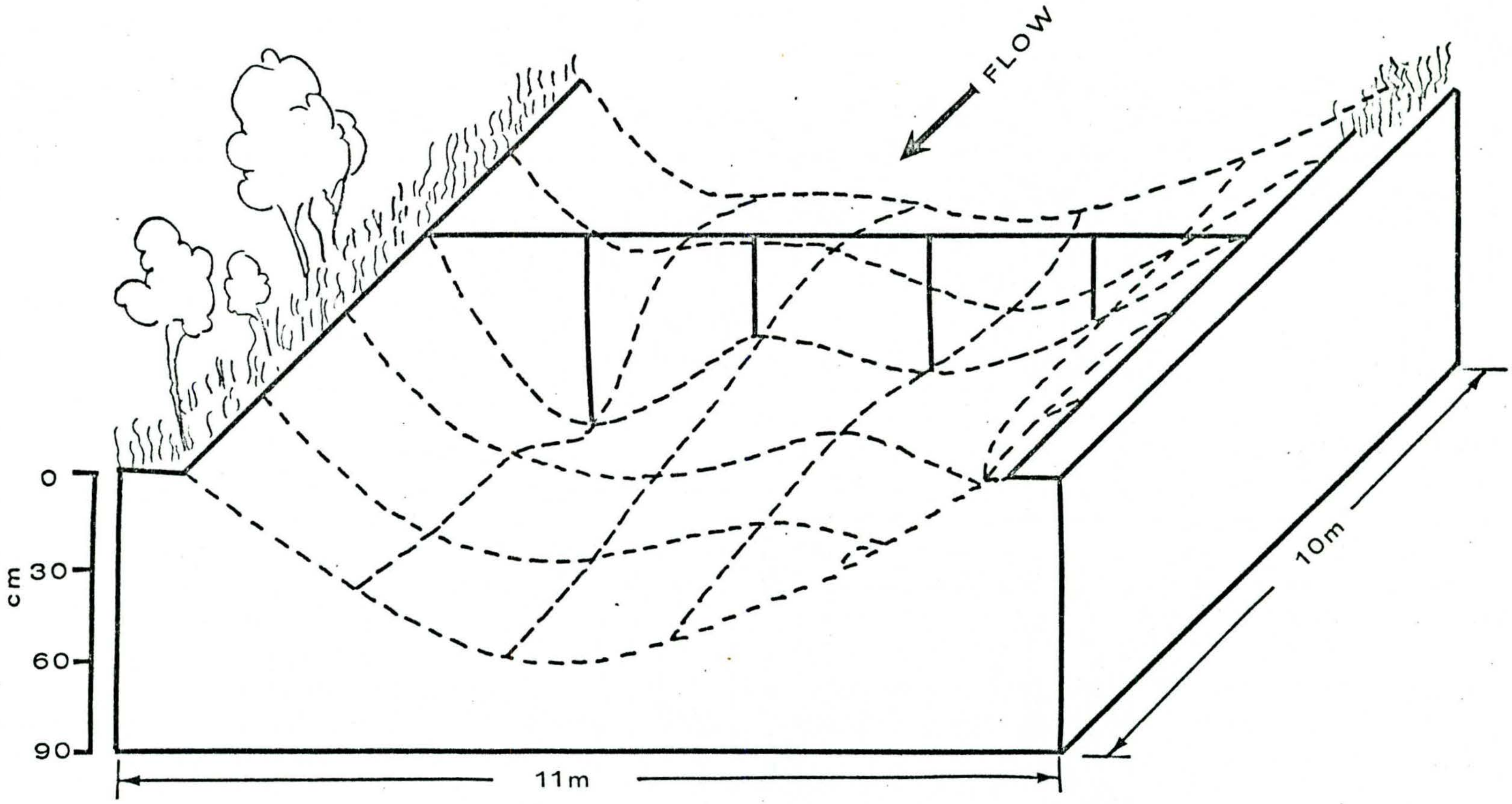

Figure 4. Bottom Topography - Mile 6.0
Little Menomonee River

Approximately 30 m downstream from the railroad bridge (mile 5.8), the third intensive study site was established. The river in this reach was divided into two channels by a small island. The major portion of the stream flowed through the eastern channel which was approximately a meter wide with a mid-channel depth of 10 cm. The bank along the west channel was relatively steep and had been cleared to the water's edge. Adjacent land, owned by Kerr-McGee Company, previously served as a storage yard for creosote-treated railroad ties. The bank along the east channel had a narrow shoal of coarse sand elevating to a cover of shrubs, grasses and small clumps of trees. Elsewhere the stream bottom consisted of rock, gravel, sand and clay with an overburden of silt and detritus 0.5 to 1.3 m (1.5 to 4.2 ft) thick [Figure 5].

The fourth intensive study site was established at mile 5.1. In this reach the river channel was nearly straight, with an average width of 4 m and maximum, mid-channel depth of 50 cm. Ash and thorny apple, as well as various shrubs and grasses covered the banks. The stream bottom was unevenly contoured and composed of gravel, sand and clay covered with an average of 0.4 m (1.2 ft) of silt and vegetative detritus [Figure 6].

At mile 4.2, the fifth intensive study site was established. The river bed contour was relatively uniform with a mid-channel, maximum depth of 30 cm. Clumps of deciduous trees, shrubs and grasses lined both stream banks. A few low-lying areas along the water's edge were inundated and portions of terrestrial plants were submerged. Adjacent land use appeared to be agricultural and extensive acreage of plowed land was observed from a river bank vantage point. The stream bottom consisted of rock, gravel and clay with an overburden of 15 to 90 cm of silt and leaf detritus [Figure 7].

The sixth intensive study site was established at mile 2.6. This reach was located in an urbanized area. Land adjacent to the river had

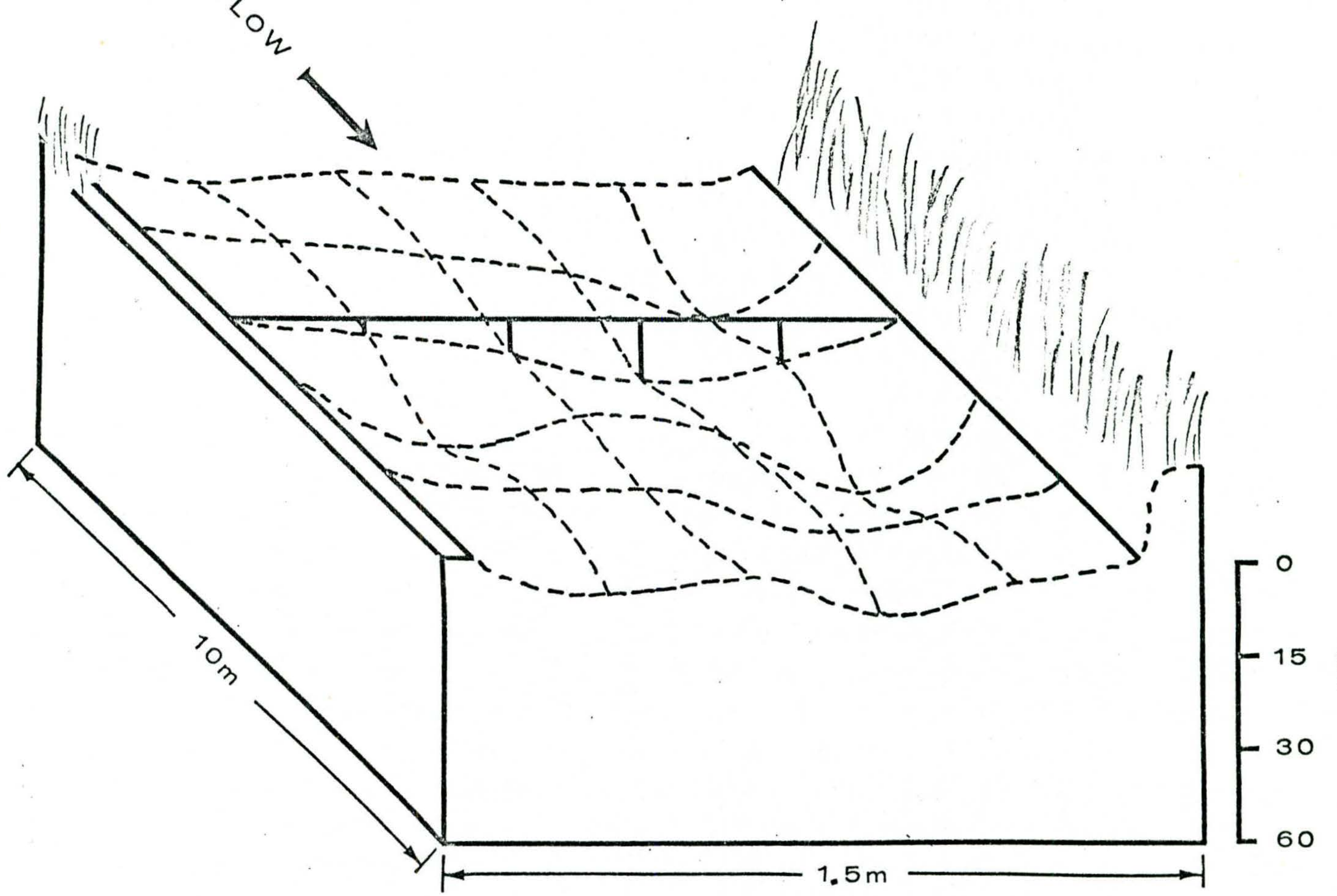

Figure 5. Bottom Topography - Mile 5.8

Little Menomonee River

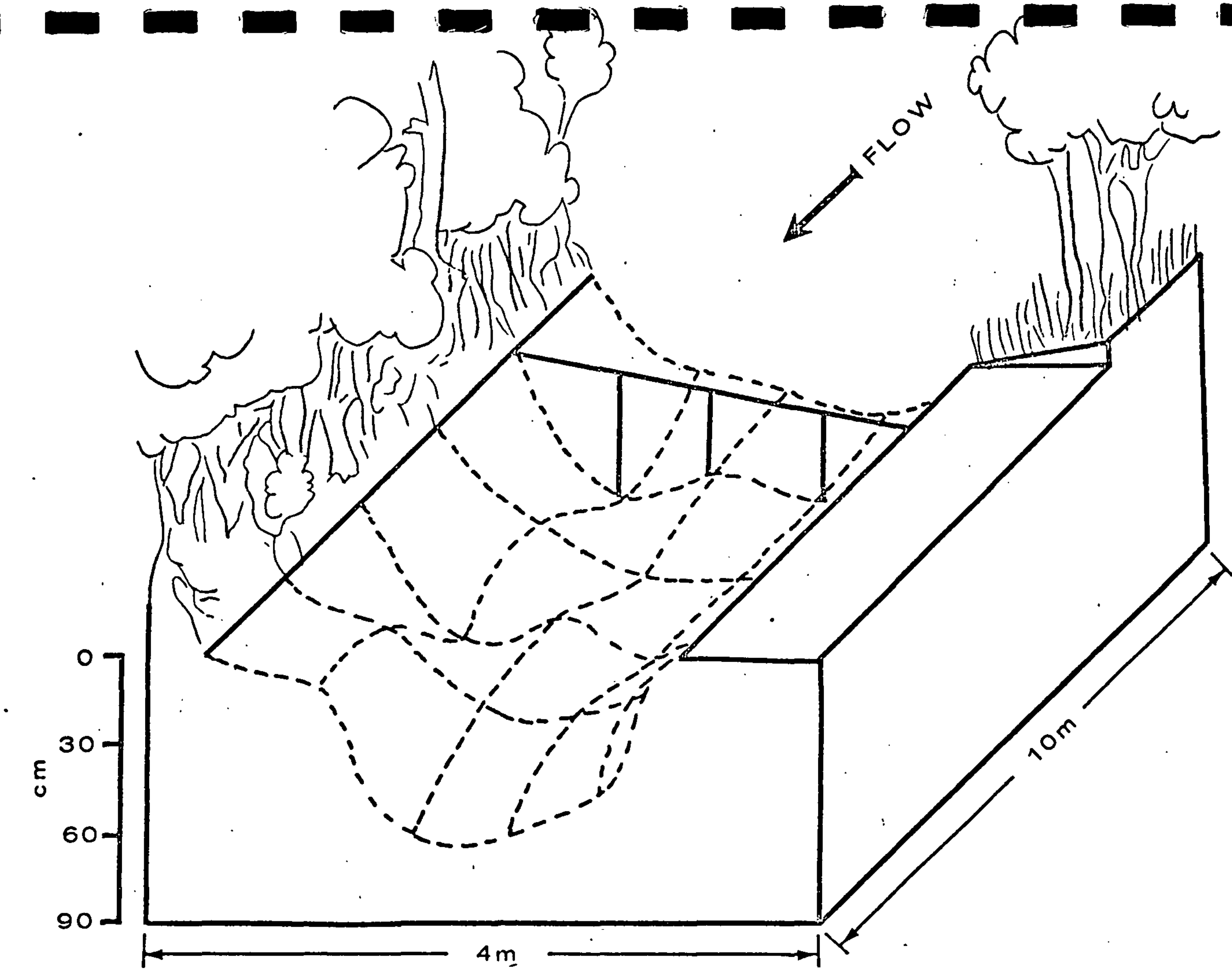

Figure 6. Bottom Topography - Mile 5.1

Little Menomonee River

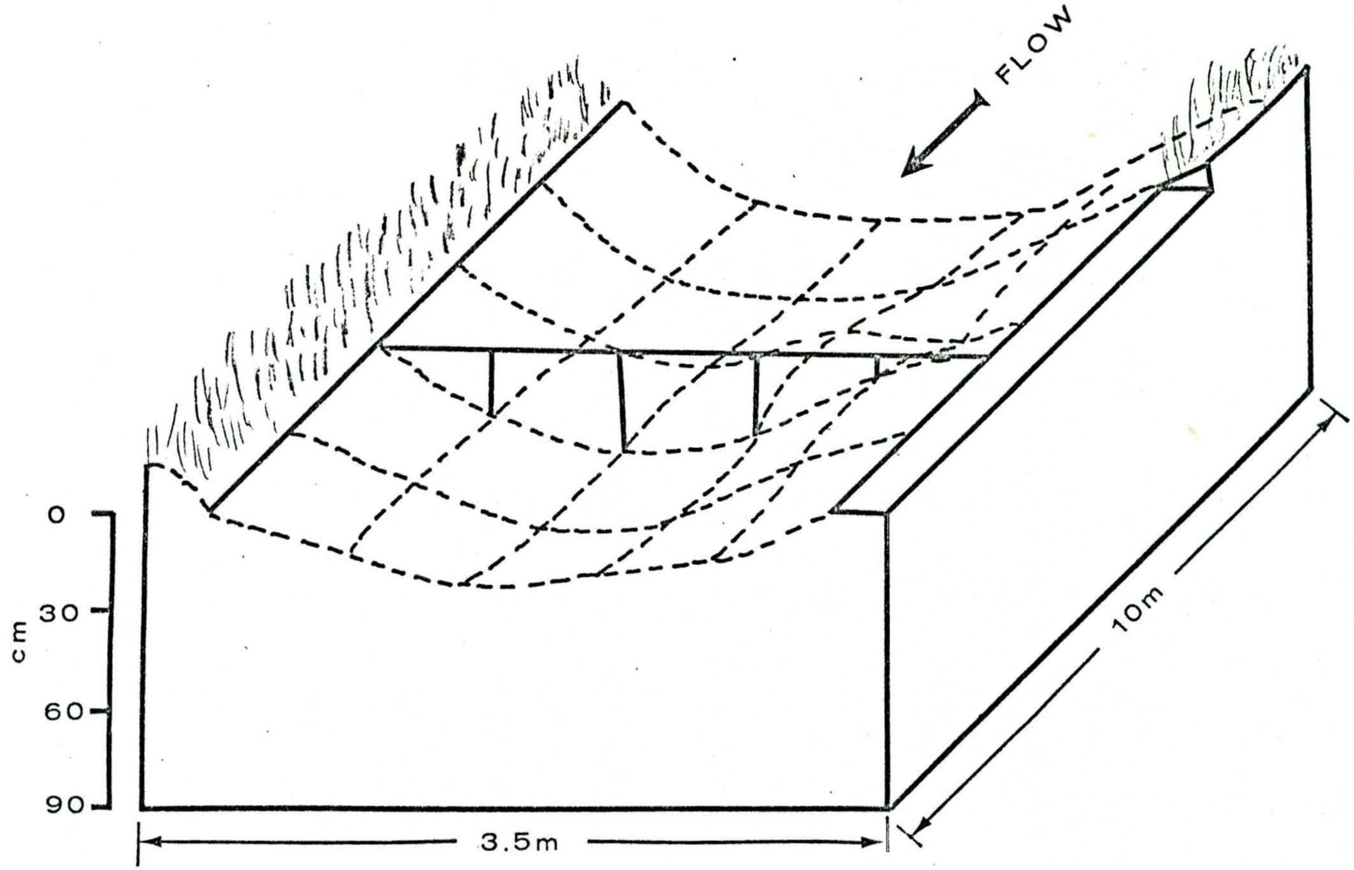

Figure 7. Bottom Topography - Mile 4.2

Little Menomonee River

been cleared and landscaped as a park. Beyond was a large residential development that paralleled both sides of the river and park area.

Immediately downstream the river course was diverted to the north and west apparently to accommodate the construction of bridges including the Fond-du-lac freeway bridge. The artificial channel was U-shaped with each leg of the U paralleling the Fond-du-lac freeway for about 100 m. This diversion and channelization marked the lower limit of the cross-section of river selected for the intensive study. The stream width averaged 8 m and mid-channel depth reached a maximum of 8 cm within the limits of the study cross-section. Bottom sediments consisted of gravel, sand and clay with a thick (30 to 60 cm) overburden of silt and some vegetative detritus [Figure 8].

A few hundred meters downstream from the Fond-du-lac Freeway bridge crossing, the seventh intensive study site was established (mile 2.0). The river channel was narrow (4 m) and littered with large rocks, fallen trees, tree limbs, other vegetative detritus and trash (cans, tires, paper, etc.). Maximum water depth at this sampling site was 60 cm. Silt and leaf drift several centimeters thick, covered the harder natural riverbed of rock, gravel, sand and clay [Figure 9].

The eighth in the series of intensive study sites in the Little Menomonee River was established at mile 1.0. Urbanization was evident; the shoreline was partially cleared and landscaped as a park area. Private residences paralleled this park area.

The river was narrow (6.5 m) and shallow (6 cm) with a stream bed composed of rock, gravel, sand and clay and an overburden of silt and vegetative litter [Figure 10].

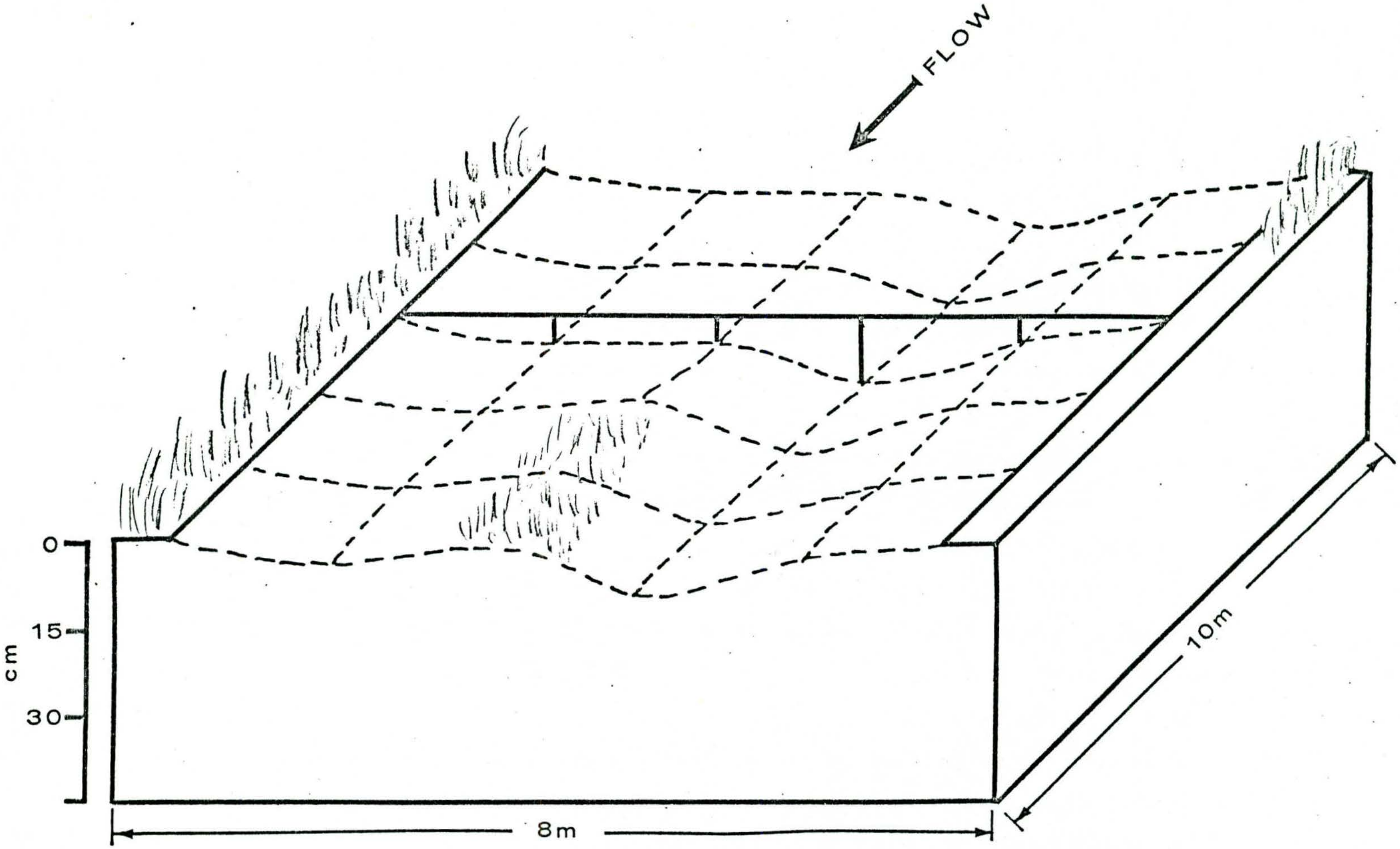

Figure 8. Bottom Topography - Mile 2.6

Little Menomonee River

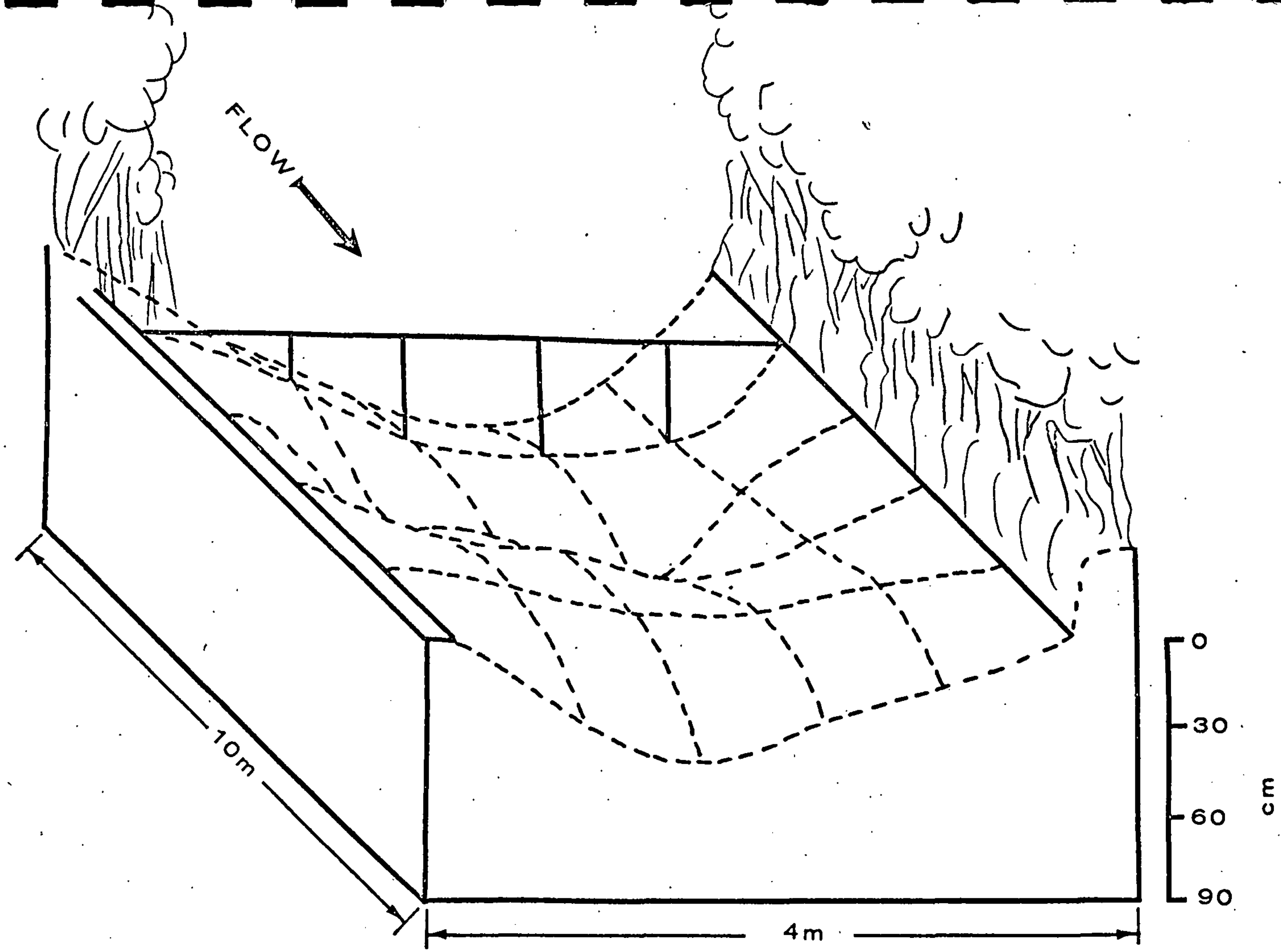

Figure 9. Bottom Topography - Mile 2.0

Little Menomonee River

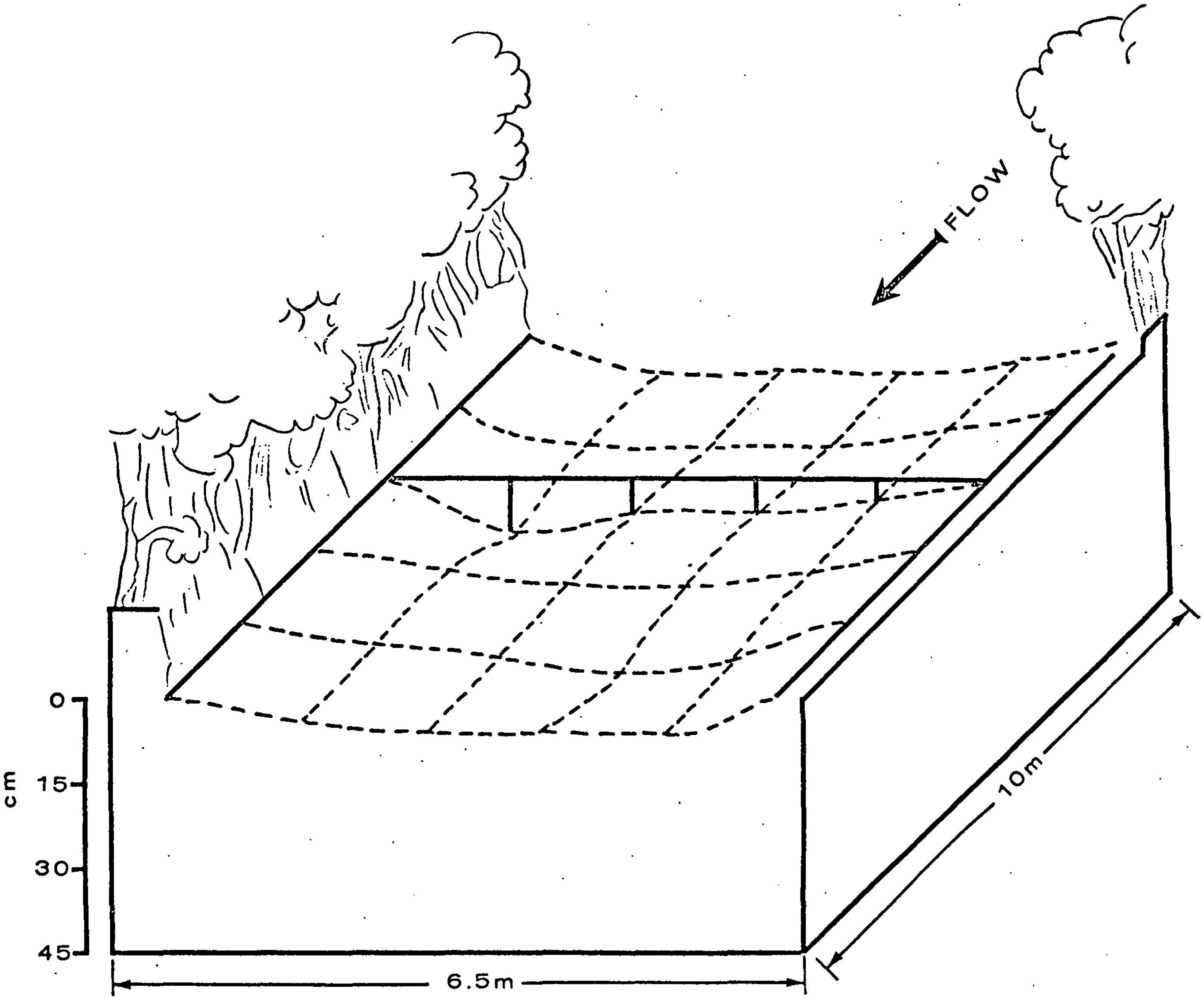

Figure 10. Bottom Topography - Mile 1.0

Little Menomonee River

Menomonee River - Mile 7.6 and 7.5*

Two sampling stations were established in the Menomonee River to determine the impact of the Little Menomonee. The upstream or reference station on the Menomonee River was located at mile 7.5 (approximately 150 m upstream of the Menomonee-Little Menomonee confluence). The winding river channel in this reach had an average width of 11 m and a mid-channel depth of approximately 15 cm. A small deciduous forest bordered the river; the banks were covered by smaller shrubs and grasses. The stream bottom consisted of coarse gravel and sand covered with a thin overburden of softer deposits, mostly silt and vegetative detritus [Figure 11].

The second station in the Menomonee River was located approximately 10 m downstream from the Little Menomonee confluence at mile 7.5. The river channel was nearly straight in this reach with an average width of 11 m. Mid-channel depth was approximately 4.5 cm. The shoreline and stream bottom appeared similar to that found upstream in the Menomonee at mile 7.6 [Figure 12].

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* *As measured from the mouth of the Menomonee River.*

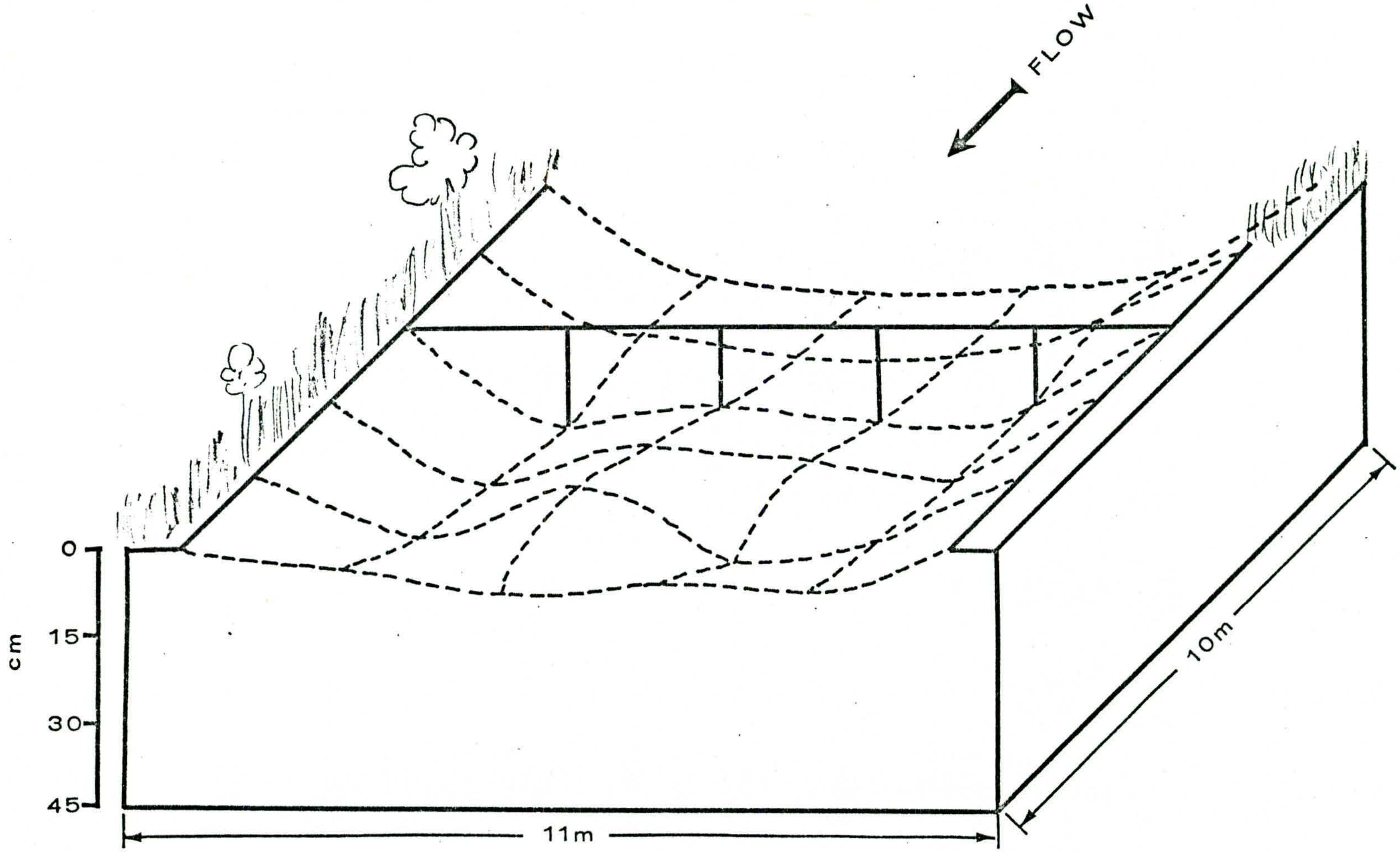


Figure 11. Bottom Topography - Mile 7.6
Menomonee River

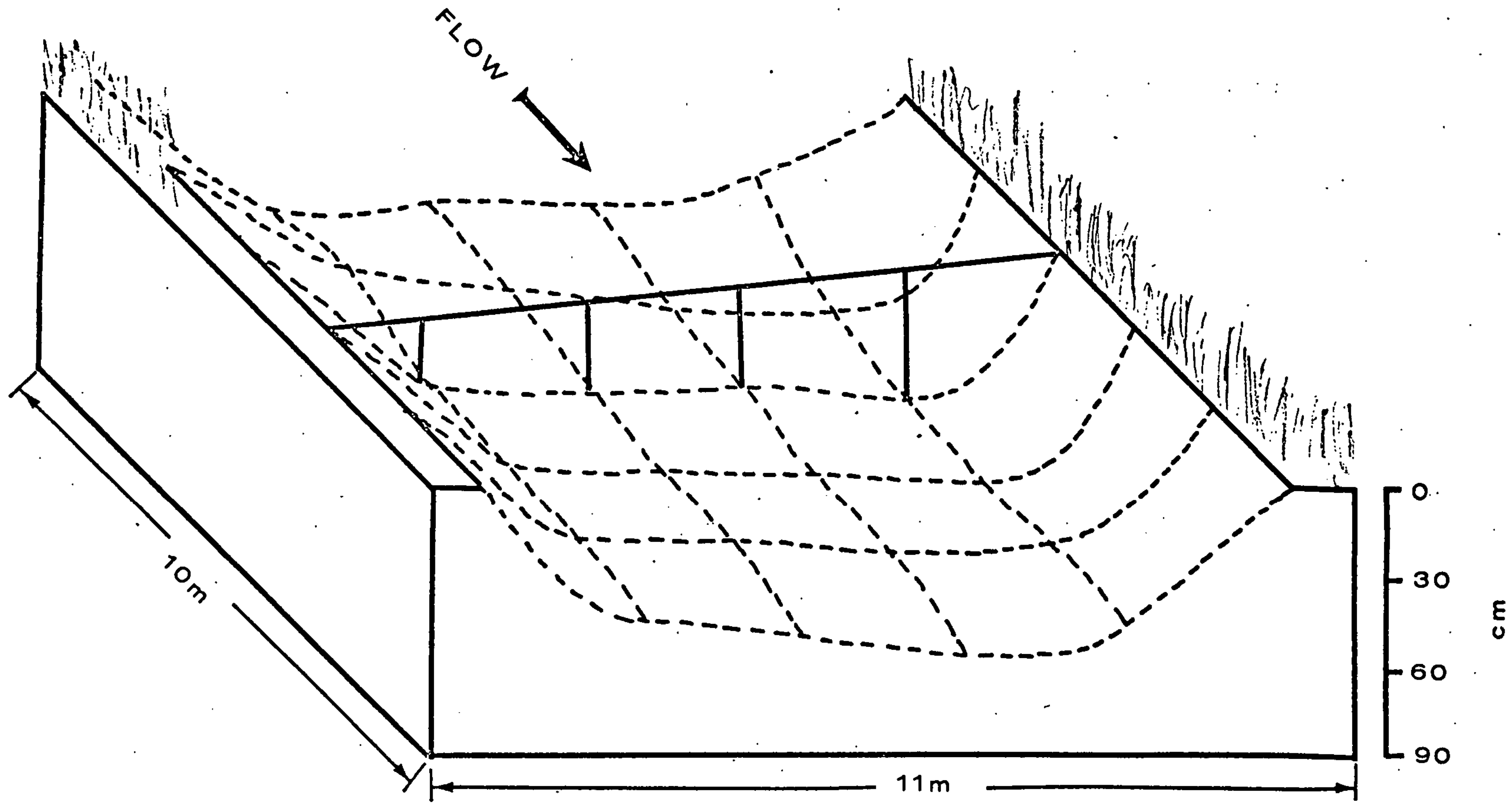


Figure 12. Bottom Topography - Mile 7.5
Menomonee River

V. ENVIRONMENTAL CONDITIONS

RIVER SEDIMENTS

Along most of the lower 12.8 km (8 mi) of the Little Menomonee River, the stream bottom was composed of rock, coarse gravel, sand and clay with a varying amount of overburden consisting of fine sand, silt and vegetative debris. There were a few small reaches where the river flood plain widened and the stream overflowed into marshes. In these areas, the stream bed consisted mostly of silt and vegetative detritus.

Upstream of the abandoned Kerr-McGee creosoting plant site at river mile 6.9, 6.5, 6.1 and 6.0, bottom deposits were collected along transects of the river. Sediment samples were examined on-site for extraneous materials resembling oil and creosote. No creosote-like deposits were observed and later laboratory analyses confirmed that none were present [Table 1].

From the Kerr-McGee creosoting plant site at approximately river mile 5.8, downstream to the Leon Street bridge crossing at mile 2.6, the stream bed was very irregular. Depressions along the river bottom often had accumulated more than 60 cm of silt. Four intensive study sites were established in the reach (mile 5.8, 5.1, 4.2 and 2.6). Bottom deposits were collected from each site in the same manner as described previously.

On-site examination of the sediment revealed extensive deposits of tar-like and oily substances in the soft river muds. In the upper portion of this stream reach (mile 5.8 to 5.1) the oily deposits appeared to be in layers approximately 6 to 10 cm thick, covered by

Table 1

CREOSOTE DEPOSITS
LITTLE MENOMONEE RIVER, WISCONSIN
April 1977

River Mile	Methylene Chloride Extractables† West River Bank	Middle River Channel	East River Bank
	g/kg		
6.9	ND††	ND	ND
6.8		ND	
6.5		ND	
6.1		ND	
6.0	ND	ND	ND
5.8	ND	3.0	7.5
5.8		8.0	
5.7		7.0	
5.4		9.0	
5.3		13.5	
5.1	24.5	10.5	ND
5.0		9.0	
4.7		9.5	
4.7	ND	ND	ND
4.5		3.0	
4.4		3.0	
4.3		5.5	
4.2	12.0	2.5	1.5
4.0		5.0	
3.7		2.5	
3.5		11.0	
2.9		3.5	
2.6	40.0	22.0	2.5
2.3		ND	
2.1		ND	
2.0	ND	2.5	2.0
1.9		ND	
1.5		7.0	
1.2		ND	
1.0	2.5	4.5-6.5	4.5
0.7		ND	
0.5		ND	
0.1		5.0	
7.6*	ND	ND	TR**
7.5*	ND	ND	ND

† *Creosote detected by gas chromatograph analysis. Values rounded to nearest 0.5 g/kg.*
†† *None detected (creosote).*
* *Menomonee River.*
** *TR = trace amount of creosote.*

several centimeters of silt. This layer of oily material was believed to be the residue of a larger deposit of creosote dredged from this river reach in 1972 by the Kerr-McGee Chemical Company and in 1973 by EPA-sponsored private contractors.

Laboratory analyses of the sediment deposits from mile 5.8 revealed creosote in concentrations as high as 7.5 g/kg.* At mile 5.1, concentrations of 10.5 and 24.5 g/kg were found [Figure 13 and Table 1]. Gas chromatography and mass spectrometry methods that were used to identify creosote in the river sediments are described in Appendix B. It is important to note that creosote values reported herein are methylene chloride extractable materials and may have up to 1 g/kg of naturally occurring organic materials in addition to creosotic materials.

From mile 5.0 downstream to 2.6, tar-like and oily deposits were observed frequently. Deposits appeared to be thicker ($\geq$ 45 cm) than those recorded upstream, nearer the Kerr-McGee creosoting plant site. Typically, these oily deposits were mixed with soft stream sediments and often confined to stream-bed depressions or quiescent shoreline areas. Much of the stream shoreline was coated with an oily sheen and when disturbed, oil slicks appeared on the water surface. Similar slicks occurred when river muds were disturbed.

Analyses of sediment cores collected between mile 5.1 and 2.6 revealed that creosote-bearing deposits (methylene chloride extractables) were unevenly distributed in the river muds, both horizontally and vertically [Figure 13, Table 1]. The largest concentration of creosote (40.0 g/kg) found in the river mud was at mile 2.6, just upstream of the Leon Street bridge. In this general area the river course was diverted to the north and west to accommodate the construction of bridges including the Fond-du-lac Freeway bridge. The diversion and channelization caused

* *Equivalent to parts per thousand (PPT).*

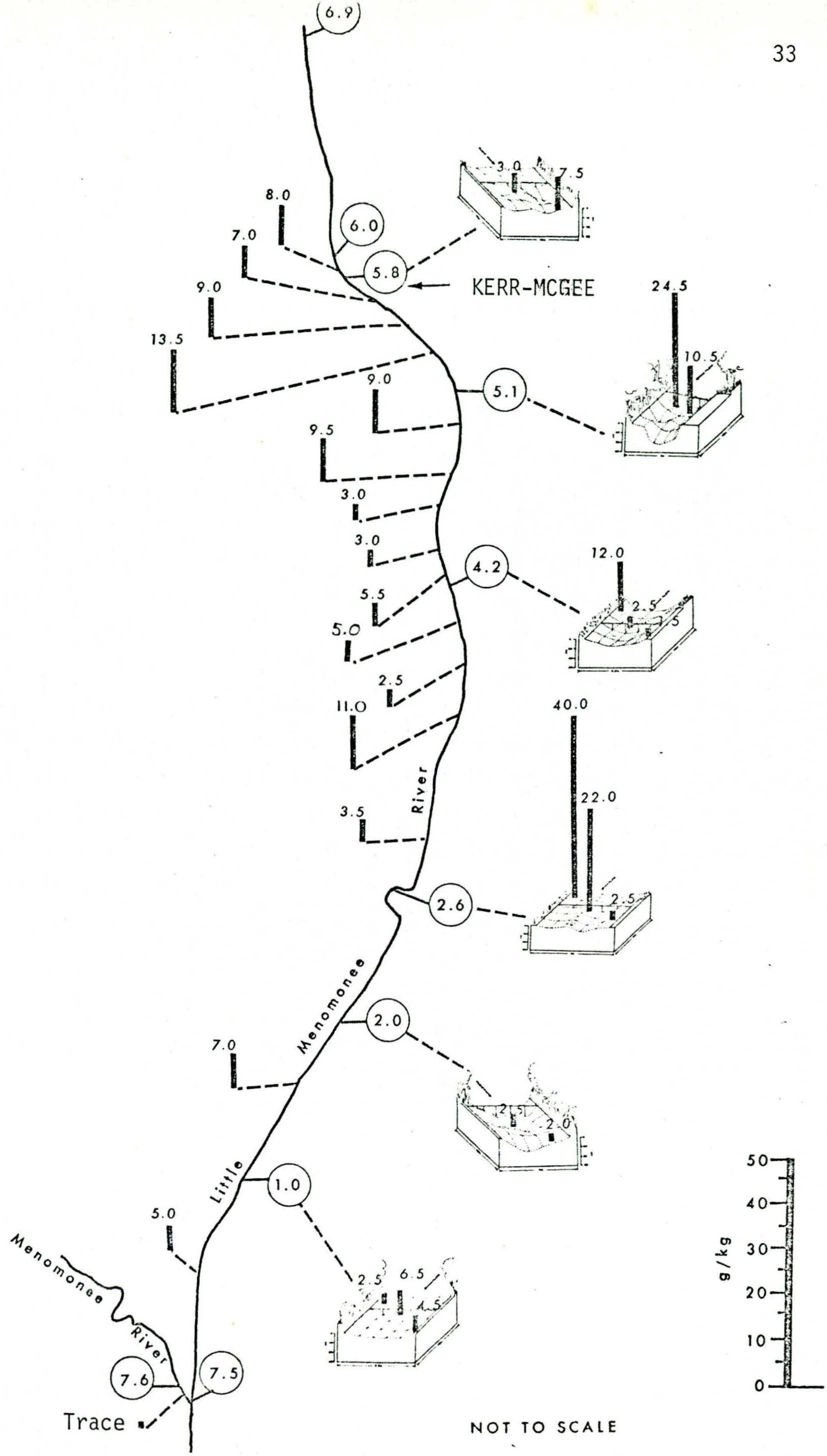


Figure 13. Profile of Creosote-Bearing Deposits in the Little Menomonee River, Wisconsin (April 1977)

a ponding effect at river mile 2.6. Apparently, the ponded area acted as a sink for silt and creosote. Examination of the deposits revealed that creosote-bearing sediments measured as thick as 65 cm.

A few hundred meters downstream from the Fond-du-lac Freeway bridge crossing, another intensive study site was established (mile 2.0). This was the general area where several local youngsters sustained chemical burns from skin contact with creosote-contaminated sediments while wading in the river in June 1971. The narrow river channel was littered with large rocks, fallen trees, tree limbs, other vegetative detritus and trash (cans, tires, paper, etc.). Core samples collected from the river bottom in this reach contained as much as 2.5 g/kg of creosote. Examination of the sediment revealed that the creosote collected in pockets or deeper depressions along the irregularly contoured bottom. The creosote-contaminated sediments were up to 35 cm in thickness.

The stream bottom at about mile 1.5 (just upstream of the Appleton Road bridge) had a deposit of creosote (7.0 g/kg) about 10 to 20 m long. Elsewhere, between mile 2.0 and 1.0, creosote-like material, oil slicks and oily muds were seldom observed in the river.

The final in the series of intensive study sites in the Little Menomonee River was established at mile 1.0. The shoreline in this river reach was partially cleared for use as a park. Private residences paralleled this park area and the Milwaukee Park District posted the areas with signs stating DANGER - POLLUTED WATER.

Core samples of the river sediment from mile 1.0 revealed creosote in concentrations ranging from 2.5 to 6.5 g/kg. Chemical analysis of the top and bottom halves of a 75 cm core collected from mid-channel showed that the surface sediment contained a creosote concentration of 4.5 g/kg while the deeper sediment contained 6.5 g/kg. Whether this trend exists elsewhere in the river is unknown.

The reach from Silver Springs bridge (mile 1.0) to the mouth of the Little Menomonee River was examined by the team of NEIC biologists. The only creosote-like deposit found in this lower reach was in the river muds at about mile 0.1. A core from this deposit revealed the presence of creosote (5.0 g/kg) in the river sediment to depth of at least 65 cm. In several other areas along this lower stream reach, oil slicks and oil sheens were observed near or in the river banks.

In the Menomonee River, one station was located approximately 150 m upstream of the Little Menomonee confluence. In this reach, the banks of the winding river were covered by deciduous trees, shrubs and various grasses. The stream bottom was comprised primarily of coarse gravel and sand. Qualitative analyses of a sediment core revealed the presence of creosote along the northeast river bank, however the amount of sediment was insufficient to accurately quantitate the amount of creosote present.

A second station in the Menomonee River was located approximately 10 m downstream from the Little Menomonee confluence. The river channel was nearly straight in this reach and the shoreline and stream bottom appeared similar to that found upstream in the Menomonee. When a core sample of the sediment was obtained, an oil slick appeared on the river surface. Additional probing along the bank and river bottom produced oil slicks also. No creosote-like deposits were observed and laboratory analysis showed no measurable amount of creosote in the sediment [Table 1].

WATER QUALITY

The Little Menomonee River is a shallow stream that occasionally carries a heavy silt load. Records from a USGS gaging station at mile 1.5 showed that the sediment discharge can range from 0.7 to 269 m. tons/day; highest values were recorded following heavy rainfalls or snowmelt events.[11]

During the stream survey in April, light rainfalls occurred and storm runoff entering the stream resuspended sediments causing the water to become extremely turbid. At these times, light penetration as measured with a Secchi disc was a few centimeters along most of the stream course. The silt load appeared to settle rapidly and turbidity decreased so that within two days after a rainfall, light penetration extended to the river bottom in most reaches.

Along the river from mile 5.8 to 2.6, where creosote-bearing sediments were common, occasional oil slicks were observed on the water surface. As mentioned earlier, similar slicks were produced when the river banks and bottom were probed sufficiently to release trapped oil and creosote-like globules from the sediment. The effect of these slicks is discussed in the AQUATIC LIFE subsection below.

Average surface water temperature along the course of the Little Menomonee varied only slightly during the survey (13.0 to 15.5°C) and the river was too shallow for vertical stratification. In a few shallow reaches between mile 4.2 and 2.6, the water temperature decreased slightly [Table 2] indicating possible groundwater inflow.

According to the Wisconsin Department of Natural Resources,[22] limestone outcrops occur along the river bed in Ozaukee County. Although none were observed along the study reach in Milwaukee County, the pH of the river was apparently affected. Along the reach studied (mile 7.9 to the mouth), the river was slightly alkaline with a pH of 7.5 to 8.5 [Table 2]. The range of pH values recorded in the Little Menomonee was typical for clean rivers that drain into the western shore of Lake Michigan.[11]

Nutrient levels were adequate to support growths of aquatic vegetation in most areas of the Little Menomonee River [Table 2]. In turn,

Table 2

SUMMARY OF PHYSICAL AND CHEMICAL CONDITIONS IN THE LITTLE MENOMONEE RIVER, MILWAUKEE COUNTY, WISCONSIN

April 1977

River Mile	Water Temperature Range (°C)	Water Temperature 5-day Avg. (°C)	pH 5-day Range	Dissolved Oxygen Range (mg/l)	Dissolved Oxygen 5-day Avg. (mg/l)	Dissolved Oxygen Max % Saturation	Total Inorganic Nitrogen-N (mg/l)	Total Phosphorus-P (mg/l)
6.9	11.0-15.0	13.0	7.5-7.9	7.5-12.5	11.1	120	3.85	0.02
6.0	12.0-18.5	15.0	7.6-8.0	8.0-12.0	11.0	130	2.53	0.05
5.8	12.0-16.5	14.8	7.6-8.1	8.0-13.0	10.1	120	2.52	0.06
5.1	13.0-15.5	15.5	7.6-8.1	9.0-15.0	11.9	120	2.42	0.06
4.2	12.5-17.0	14.9	7.6-8.3	9.5-13.5	11.8	135	2.13	0.04
2.6	12.0-17.0	14.3	7.6-8.3	8.5-13.0	11.0	125	1.84	0.03
2.0	12.5-19.9	15.4	7.6-8.2	9.5-15.0	12.3	160	1.68	0.05
1.0	12.0-20.0	14.6	7.6-8.2	9.5-15.0	12.5	160	1.36	0.45
MR 7.6†	13.0-20.0	15.7	7.6-8.5	8.0-15.0	12.0	160	2.92	0.37
MR 7.5	13.5-21.5	15.8	7.6-8.3	8.5-16.5	12.5	170	2.78	0.22

† *Menomonee River.*

the vegetative growth apparently supplemented the river's oxygen supply. Dissolved oxygen concentrations were measured during daylight hours and ranged from 7.5 to 15.0 mg/l. This constituted a supersaturation level as high as 160%. Diel conditions were not determined but evidence that the dissolved oxygen content never declined to unsuitable levels was obtained from fish survival studies performed at 8 locations in the river.

In summary, other than oil slicks and occasional high levels of turbidity, physical and chemical conditions described above indicated that the Little Menomonee River in Milwaukee County had an acceptable water quality [Appendix C].

AQUATIC LIFE

Vegetation

The Little Menomonee River varied only slightly in depth (<150 cm) in the lower 7-mile reach that was studied. Consequently, the littoral zone, or area where aquatic plants could grow, was quite large.

In reaches of negligible gradient, the river often overflowed into marshes of cattails (*Typha*), reeds (*Phragmites*) and bullrushes (*Scirpus*). Elsewhere the river margin and banks were covered with sparse to heavy growths of terrestrial grasses, shrubs and deciduous trees.

At mile 6.0, upstream of the abandoned creosoting plant, shallow water and debris provided an adequate habitat for a diverse diatom flora (12 kinds). Additionally, small growths of elodea (*Anacharis*) and three types of filamentous green algae were present [Table 3].

In another reach (mile 6.0) upstream of the creosoting plant site,

Table 3
AQUATIC PLANTS IN THE LITTLE MENOMONEE RIVER
April 1977

	Little Menomonee River at River Mile									Menomonee River	
	6.9	6.0	5.8	5.1	4.7	4.2	2.6	2.0	1.0	7.6	7.5
Phylum Chlorophyta											
Order Chlorococcales											
Family Scenedesmaceae											
Scenedesmus sp.										X	
Family Hydrodictyaceae											
Pediastrum sp.										X	
Order Ulotrichales											
Family Ulotrichaceae											
Binuclearia sp.	X										
Ulothrix sp.	X	X	X	X	X	X	X	X	X	X	X
Order Chaetophorales											
Family Chaetophoraceae											
Microthamnion sp.	X										
Order Siphonocladales											
Family Cladophoraceae											
Cladophora sp.								X			
Order Zygnematales											
Family Zygnemataceae											
Spirogyra sp.			X	X	X	X	X	X	X		X
Family Desmidiaceae											
Closterium sp.				X	X		X			X	X
Phylum Euglenophyta											
Order Euglenales											
Family Euglenaceae											
Lepocinclis sp.								X			
Phacus sp.						X					
Phylum Chrysophyta											
Order Centrales											
Family Coscinodiscaceae											
Melosira sp.	X		X								
Cyclotella sp.	X			X	X		X			X	
Family Rhizosoleniaceae											
Rhizosolenia sp.			X						X		X
Order Pennales											
Family Fragilariaceae											
Fragilaria sp.	X		X		X	X	X		X	X	X
Meridion sp.	X					X		X	X	X	X
Synedra sp.	X	X	X	X	X	X	X	X	X	X	X
Family Achnanthaceae											
Cocconeis sp.	X	X	X	X		X	X	X	X	X	X
Rhoicosphenia sp.	X										
Family Naviculaceae											
Caloneis sp.	X			X				X	X	X	X
Gyrosigma sp.	X		X	X		X	X				
Navicula sp.	X	X	X	X	X	X	X	X	X	X	X
Neidium sp.										X	
Stauroneis sp.								X			X
Family Gomphonemaceae											
Gomphonema sp.					X	X	X		X	X	
Family Cymbellaceae											
Cymbella sp.	X	X									
Family Nitzschiaceae											
Nitzschia sp.	X	X	X	X	X	X		X	X	X	X
Family Surirellaceae											
Cymatopleura sp.			X	X	X		X		X		X
Surirella sp.			X							X	
Phylum Cyanophyta											
Order Oscillatoriales											
Family Oscillatoriaceae											
Oscillatoria sp.			X	X	X	X	X	X	X		X
Schizothrix sp.		X	X	X	X				X		
Spirulina sp.				X							
Phylum Spermatophyta											
Order Monocotyledonales											
Family Potamogetonaceae											
Potamogeton sp.		X		X							
Family Hydrocharitaceae											
Elodea sp.	X										
Family Lemnaceae											
Lemna sp.		X									
Order Dicotyledonales											
Family Ceratophyllaceae											
Ceratophyllum sp.		X									
Number of Types (35 total)	16	10	14	15	12	12	12	12	14	15	14

the flora of a marsh was studied. The poorly-defined river margin was covered with large stands of cattails and a few scattered clumps of willows, reeds and bullrushes. Attached to these plants were periphytic diatoms (5 kinds) and a growth of green algae (*Ulothrix*). Sparse growths of blue-green algae, *Schizothrix* were present also. Quiescent surface water of the marsh had growths of duckweed (*Lemna*) and portions of the stream bed provided habitat for such vascular plants as *Certophyllum* and *Potamogeton* [Table 3].

The abundance and diversity of aquatic plant life at mile 6.9 and 5.9 indicated the river had good quality water.

Downstream from the Kerr-McGee plant site (mile 5.8) to the confluence with the Menomonee River, green (4 types) and blue-green algae (3 types) were common. Areas with large quantities of creosote (mile 5.0 to 2.6) in river muds appeared to have a sufficient overburden of clean silt, sand, gravel and detritus to isolate the algal habitat from the contaminated sediment. The pattern and community structures of periphyton were similar to growths found in the uncontaminated upstream reach of the Little Menomonee River (mile 6.0 and 6.9).

Rooted aquatic plants were found less often downstream from mile 5.0 than upstream. Although this correlated with creosote deposits, there may have been other factors such as bottom type, siltation or flow conditions that precluded establishment of these types of plants.

Just upstream of the Leon Terrace bridge crossing at mile 2.6, the roots, stems and leaves of cattails and other wetland vegetation were coated with tar-like material. Chemical analyses of this vegetation sample revealed the plants were heavily coated with creosote (30% by weight).

In summary, creosote deposits in river muds may preclude the establishment of rooted aquatic plants. However, most of the floral communities did not seem adversely affected by underlying creosote deposits in the river muds.

Macroinvertebrates

The Little Menomonee River provided a habitat for 53 kinds of aquatic macroinvertebrates [Table 4]. Distribution of these organisms reflected changing environmental conditions in the river, both natural and pollutional.

Upstream of the abandoned Kerr-McGee creosoting plant, macroinvertebrates were collected from two reaches. At mile 6.9 the collections were made from a small riffle and pool area. As is usually characteristic in good quality water, the riffle was populated with immature caddisflies, mayflies, beetles and midges as well as crustaceans and various kinds of mollusks. Surface-dwelling water bugs were observed and collected from quiescent shoreline areas. Bottom mud in the pool was inhabited by a variety of midge larvae, aquatic worms, snails and clams.

The second sampling area was at the lower end of a marsh (mile 6.0) just upstream of the Brown Deer Road bridge crossing and the abandoned creosoting plant. Of the habitats examined, the submerged roots, stems and leaves of cattails were the richest in macroinvertebrates. When washed in a dipnet, these plants yielded mayfly and damselfly nymphs, midge larvae, water bugs, beetle larvae and adults, along with other kinds of insects, crustaceans, and a few mollusks. Bottom mud contained a lesser variety; organisms collected from the mud included aquatic worms, crustaceans, clams, snails, midge larvae and a few immature mayflies and dragon flies.

Table 4

MACROINVERTEBRATES IN THE LITTLE MENOMONEE RIVER
April 1977

	Little Menomonee River at River Mile								Menomonee River at River Mile	
	6.9	6.0	5.8	5.1	4.2	2.6	2.0	1.0	7.6	7.5
Phylum Annelida										
Class Oligochaeta										
Order Plesiopora										
Family (earthworms)						X	11			
Family Lumbriculidae	(43)†									
Family Tubificidae						(43)				
Limnodrilus angustipenis					(43)	(301)			X	X
Limnodrilus cervix										
L. Claparedeanus			X†††		85 (129)	(387)	21	(258) X	22	(429) X
L. Hoffmeisteri	22†† (258)		258			(43)				
L. spiralis					32 (43)	(43)				
L. udekemianus	(43)									
immature without capilliform chaetae	43 (43)	(129)	258 X		22	(301)	11	(215)	32 X	(516) X
Tubifex tubifex					11					
immature with capilliform chaetae	(43)	(43)				(86)			22	
Class Hirudinea						X				
Order Rhyncobdellida										
Family Glossiphoniidae								(43)		
Placobdella sp.										
Phylum Arthropoda										
Class Crustacea										
Order Isopoda										
Family Asellidae										
Asellus sp.	32	X		X		X	32	X	X	
Order Amphipoda										
Family Talitridae										
Hyalella azteca		X	43			X				
Order Decopoda										
Family Astacidae		X	X	X	X	X	X	X		
Class Insecta										
Order Collembola		(43)								
Order Hemiptera								X		
Family Corixidae		X								
Family Saldidae	X	X								
Order Odonata										
Family Coenagrionidae										
Ischnura sp.		X			X				X	X
Family Libellulidae										
Orthemis sp.		X								

Table 4 (Cont.)

MACROINVERTEBRATES IN THE LITTLE MENOMONEE RIVER
April 1977

	Little Menomonee River at River Mile								Menomonee River at River Mile	
	6.9	6.0	5.8	5.1	4.2	2.6	2.0	1.0	7.6	7.5
Order Ephemeroptera										
Family Caenidae										
Caenis sp.	(43)									
Family Baetidae										
Baetis sp.		X								
Order Trichoptera										
Family Hydropsychidae										
Hydropsyche sp.	11		43							
Family Psychomyiidae					X					
Order Diptera										
Family Simuliidae	463									
Family Stratiomyiidae										
Stratiomys sp.	11					X				
Family Culicidae										
Aedes sp.		X		X					11	
Family Ceratopogonidae	(172)	(43)	129						X	X
Family Tabanidae		(43)								
Family Chironomidae	(43)		990	(43)	11					
Atanytarsus sp.				X				X		
Cardiocladius sp.							X			
Chryptochironomus sp.	(172)	(86)		X						
Conchapelopia sp.		(43)		X	X				43	X
Cricotopus sp.	1830 (43)	X	5123	X	108	X	32	(43)	65	(86)
Dicrotendipes sp.	11(215)	(43)	43	(43)						
Endochironomus sp.		(172)	86	(215)						
Eukiefferiella sp.	22								X	
Guttipelopia sp.		X	X	X					1	
Harnischia sp.	(172)	(1076)								
Parachironomus sp.		(215)	129	(43)	X	X		X		
Paratanytarsus sp.	22(172)	X	129							X
Polypedilum sp.	(86)	(258)							X	X
Procladius sp.	(129)			X	(43)	(43)		X	X	X
Psectrocladius sp.		X							X	
Tanytarsus sp.	(86)	(43)		(43)						
Order Coleoptera	(43)						X		X	
Family Chrysomelidae										
Donacia sp.		(43)								
Family Psephenidae										
Ectopria	X									
Family Haliplidae										
Haliplus sp.						X				
Brychius sp.	(43)	X								

Table 4 (Cont.)

MACROINVERTEBRATES IN THE LITTLE MENOMONEE RIVER
April 1977

	Little Menomonee River at River Mile								Menomonee River at River Mile	
	6.9	6.0	5.8	5.1	4.2	2.6	2.0	1.0	7.6	7.5
Family Elmidae										
Opistoservus sp.	226				(43)					
Dubiraphia sp.	22 (172)	(43)								
Microcylloepus sp.	22 (43)									
Phylum Mollusca										
Class Gastropoda										
Order Pulmonata										
Family Physidae										
Psysa sp.	(43)	(12.9)	43	(258)	X	(473)	21			X
Family Lymnaedae										
Lymnaea sp.					43				X	X
Class Pelecypoda										
Order Eulamellibranchia										
Family Sphaeriidae										
Sphaerium sp.	22	X	X						X	
Pisidium sp.	11		86		32 (258)	(774)		(43)	X	(258)
Total #/m^2	2770 (2107)	(2452)	7360	(645)	345 (559)	(2,451)	128	(602)	206	(989)
Total types	27	31	17	13	15	17	8	11	18	14

† *(Numbers of organisms/m^2 in sample from pool habitat)- these numbers appear in parentheses.*

†† *Numbers of organisms/m^2 in sample from riffle habitat.*

††† *Indicates presence.*

The macroinvertebrate communities at mile 6.9 and 6.0 comprised of 41 kinds of organisms with relatively few individuals (11 to 1,076/m^2) representing a particular species, were considered typical for small streams like the Little Menomonee. Therefore, downstream communities of invertebrates were compared with the communities present within this reference reach.

Macroinvertebrates were collected in riffles, pools or marsh-like areas from near the abandoned creosoting plant at mile 5.8 to the stream confluence with the Menomonee River. Compared with the reference reach, a decrease in diversity of organisms was evident. Water bugs and aquatic stages of mayflies, dragonflies and blackflies were not found downstream from the creosoting plant site. Collections from several locations in this lower reach that seemed ecologically suited for immature caddisflies, damselflies and aquatic beetles did not yield them either [Table 4].

Creosote deposits and related oil slicks appeared to be responsible for at least part of the reduction in the macroinvertebrate community. Invertebrate populations were sparse to absent in submerged vegetation and other aquatic niches that were coated with oily residue. Mud burrowing and sediment-browsing organisms (benthos) appeared to avoid river mud that was polluted with creosote. The macroinvertebrate collection from river mile 5.1 seemed to demonstrate the avoidance best.

Creosote concentrations of 10.5 and 24.5 g/kg were found at mile 5.1 in the soft river muds. Aquatic worms (oligochaetes) normally burrow in these soft muds but were not found there. An intensive study revealed that only a few fly larvae, snails and crayfish inhabited this reach, mostly the eastern shoreline which was apparently free from creosote contamination [Table 4].

Factors such as other pollutants, variable flow conditions, etc. may have influenced the invertebrate populations in the lower river but creosote pollution appeared to be a contributing factor also.

Fish

Seven river reaches were selected for electrofishing studies to determine the native fish population in the Little Menomonee River. Additionally, two reaches in the Menomonee River near the mouth of the Little Menomonee were studied.

At the time of the spring survey, the fish fauna of the river system was composed of 10 species. The most common species collected were white sucker (*Catostomus commersoni*), northern creek chub (*Semotilus atromaculatus*) and brown bullhead (*Ictalurus nebulosus*).

Electrofishing study sites upstream of the abandoned Kerr-McGee creosoting plant included a small riffle area (mile 7.9) and a marshland pool (mile 6.5). White sucker, creek chubs, and darters inhabited the riffle while brown bullhead were common in the pool area [Table 5]. Similar fish communities were found downstream from the abandoned creosoting plant site (mile 5.6 to 0.4), indicating that creosote residues in river muds had little or no effect upon the fish population.

Further evidence that the creosote deposits in the Little Menomonee River did not impart toxic substances into the water was obtained from *in-situ* fish survival studies performed at 9 locations in the river. Caged river chub survived the one-week exposure test both upstream (6.9 and 6.0) and downstream (7 locations between mile 5.8 and 1.0) from the Kerr-McGee plant site. Daily examination of these test fish revealed no signs of stress or unhealthy conditions attributed to creosote contamination.

Table 5

FISH IN THE LITTLE MENOMONEE RIVER
April 1977

	Little Menomonee River at River Mile							Menomonee River	
	7.9	6.5	5.6†	5.0	3.6	2.0	0.4	7.6	7.5
FISH									
Class Osteichthyes									
Order Salmoniformes									
Family Umbridge									
Umbra limi - Central Mudminnow							1		
Order Cypriniformes									
Family Cyprinidae									
Cyprinus carpio - Carp			1					1	1
Notropis cornutus - Common Shiner								1	
Pimephales promelas - Fathead Minnow						3		1	
Rhinichthys atratulus - Blacknose Dace					2				
Semotilus atromaculatus - Creek Chub	3				1	1	10	6	
Family Catostomidae									
Catostomus commersoni - White Sucker	3		8			4		19	3
Order Siluriformes									
Family Ictaluridae									
Ictalurus nebulosus - Brown Bullhead		2	18	4					1
Order Perciformes									
Family Centrarchidae									
Lepomis cyanellus - Green Sunfish			1		4				1
Family Percidae									
Etheostoma flabellare - Fantail Darter	1								

† *Topographical conditions precluded effective electrofishing.*

APPENDICES

APPENDIX A
FIELD INVESTIGATION TECHNIQUES

In-situ toxicity tests were performed at ten locations in the Little Menomonee River. Caged fish were exposed at each of these sites for approximately one week. Daily, biologists visited each site to examine the test organisms. Important water quality parameters (temperature, DO, pH) were also recorded during these visits.

The survey team traveled the lower 11.2 km (7 mi) of the Little Menomonee River in a small boat. Sediments were observed in this reach for the presence of creosote-like material, and from these observations sampling stations were selected for subsequent intensive water quality analyses and sediment profiling. The survey team determined the physical, chemical and biological conditions at each of these stations.

Physical characteristics were determined within a network grid established along a 10 m reach at each station. Parameters measured included stream width and depth, stream bottom and shoreline contour, water temperature, bottom type, and water transparency. Core samples of stream sediment were collected systematically from three points within the network grid at each station. This provided for a stream-wide analysis of sediment composition at each station. These cores were grossly examined for oily deposits and subsequently shipped under chain-of-custody (Appendix D) to the NEIC Denver laboratory for oil and creosote residue analyses.

Chemical conditions (pH and DO) were recorded on-site at each intensive sampling station. Water samples were also collected from selected areas within each sampling cross-section for additional laboratory examination which included nutrients (inorganic nitrogen and phosphorus) and where necessary, oil and creosote analyses.

A comprehensive biological investigation was conducted at each intensive station also. This phase of the investigation included the collection, examination and identification of benthic macroinvertebrates, periphyton, aquatic vegetation and fish. The purpose of this collecting was to take representative species which were established in the various reaches of the Little Menomonee River.

PERIPHYTON AND HIGHER PLANTS

Since the river was shallow, collections were made while wading the stream. Roots and stems of higher aquatic plants were scraped to collect attached or epiphytic forms. Portions of large mats of filamentous algae were collected. Key portions or entire higher plants were uprooted. Samples were placed in collecting jars, preserved with 5% formalin and labeled in the field.

Upon returning to the NEIC laboratory the collections were examined, separated and identified according to standardized techniques.[2,3]

AQUATIC MACROINVERTEBRATES

The majority of invertebrates were collected from the Little Menomonee River with either an Eckman dredge (pool habitats) or surber square foot sampler (riffle habitats). In this method, a portion of the habitat to be examined was collected and washed thoroughly to remove all the fine sediment which will pass through the mesh. The washed residue was then transferred into some clean water in a white enamel tray and the invertebrates were picked out with forceps as they move against the white background. This method provided an estimate of the density of organisms.

In a second, qualitative method, a thorough search of all available habitats was made at each intensive sampling location for a period of one hour. Invertebrate organisms were picked from a variety of substrates such as vegetation lining the river banks and branches or twigs which had fallen into the stream. This method, although qualitative, provided an inventory of most of the invertebrates inhabiting each intensive sampling site.

In the field, invertebrates were placed in 70% alcohol for preservation. Subsequently, at the NEIC laboratory the organisms were separated and identified according to standardized methods.[2,3]

FISH

Debris, irregular bottom and vegetative snags precluded seining; thus, all fish collecting was accomplished by use of a portable AC, pulsed DC, electroshocking equipment.

Since the entire fish population can never be collected there will always be a certain amount of sampling variability. The absence of any given species from the list presented in this document does not mean that the species never occurs at the location sampled. Conclusions developed in this document are based upon the presence of groups of species in the area rather than the absence of any one species.

APPENDIX B
LABORATORY ANALYTICAL TECHNIQUES

On April 21 and 26, 1977, 59 sediment, 1 vegetation and 11 water samples were received at the NEIC laboratory. All samples were handled according to chain-of-custody procedures developed by the NEIC (Appendix D).

The eleven water samples were analyzed for NO_2 + NO_3N, NH_3-N, and Total Phosphorus. The other 60 samples were analyzed for moisture and methylene chloride extractables.

Nutrient samples were preserved with 40 mg/l $HgCl_2$ and cooled with ice for shipment. Analyses were performed according to appropriate autoanalyzer procedures as approved by EPA in the Federal Register, Vol 41, No. 232, Dec. 1, 1976.

For moisture analyses, about 10 grams of thoroughly mixed sample were accurately weighed in a tared 50 ml beaker and dried overnight in an oven at 105°C. The water loss was determined by reweighing the cooled and desiccated beakers. Calculations:

$$\frac{\text{Wt. of water loss}}{\text{Wt. of sample wet}} \times 100 = \%\ \text{moisture}$$

METHYLENE CHLORIDE EXTRACTABLES

To begin preparation for methylene chloride extractable analyses, ten grams of thoroughly mixed sediment were weighed into a 250 ml beaker. Large stones, twigs, leaves, etc. were not analyzed. Thirty grams of granular anhydrous sodium sulfate was added to the beaker and the sediment and sodium sulfate was mixed thoroughly to obtain a coarse granular consistency. The mixture was then transferred to a 33 x 80 mm cellulose extraction thimble and placed in a Soxhlet extractor. Methylene chloride (200 ml) was placed in a 500 ml flat bottomed flask and attached to the extractor. The extractor was allowed to cycle for 2-1/2 to 3 hours, with a rate of about 10 cycles per hour. Each flask was then placed on a rotary evaporator and the solution was concentrated to a volume of about 20 ml. The remaining solvent was quantitatively transferred to a tared 50 ml beaker and evaporated to dryness on a warm hot plate under a gentle stream of carbon-filtered air. Each beaker was reweighed and the residue determined. Results were calculated on a dry weight bases using % moisture values.

$$\frac{\text{Wt. of residue in mg}}{\text{Wt. of sediment extracted in g. wet}} \times 1000 = \text{mg/kg (wet basis) extractable material}$$

$$\text{mg/kg wet basis} \times \frac{100}{100 - \%\ \text{mist}} = \text{mg/kg (dry basis) extractable material}$$

OR

$$\frac{\text{Wt. of residue in mg}}{\text{Wt. of sediment extracted wet} \times \%\ \text{solids in grams}} \times 1000 = \text{mg/kg dry basis}$$

% solids = 100 - % moisture

CREOSOTE IDENTIFICATION

Methylene chloride was chosen as an extracting solvent because of its superior ability to extract organic materials; creosote is a coal tar residue product containing many high-boiling asphaltic materials soluble in methylene chloride.

Methylene chloride will extract materials other than creosote that are present in the samples. No solvent is entirely selective for any one group of compounds. Thus, samples that contained no evidence of creosotic materials or petroleum-based products may contain a "natural background" of extractable organic materials. In general, these "natural backgrounds" were found to be less than 1000 mg/kg. Therefore, it was estimated that any reported values of methylene chloride extractable material may have about 1000 mg/kg of naturally occurring material in addition to the creosote. An exception to this was a sample from the Menomonee River at mile 7.6. This sample consisted of rocks from 20 mm diameter to gravel-sized pieces, plus a small amount of sand and very little sediment or mud. A large amount of sample (80 g) was extracted, accounting for a better detection limit. No naturally occurring background material was observed.

Each of the 59 sediments and the vegetation sample were analyzed by gas chromatography. The methylene chloride extracts were dissolved in 10 ml of acetone and an aliquot was injected on a Hewlett-Packard 7626 gas chromatograph equipped with a flame ionization detector. Chromatograms of the sediment extracts were compared to chromatograms of reference creosote samples. Four sources were used as references for the sediment chromatogram comparisons. Both reference sample #1 and #2 were from the Kerr-McGee plant site. Reference # 1 is from a holding tank used to store raw creosote at the plant. Reference #2 was scraped from the bottom of a creosote recovery tank located on the Kerr-McGee property. References #3 and #4 were from two separate sources in the Denver area.

Examination of the reference chromatograms shows that all four of these samples exhibited remarkably similar "Fingerprint" tracings. There are many compounds common to all four references. Ratios of response of one compound to another are also similar among all four references.

Most Little Menomonee samples exhibited a "fingerprint" chromatogram resembling the reference creosote samples. A number of creosote compounds were identified by combined gas chromatography-mass spectrometry. Four polynuclear aromatic hydrocarbons (anthracene, phenanthrene, fluoranthene, and pyrene) seemed to be the most persistent creosotic materials. Several samples were quite weathered, but still exhibited the general creosote pattern including the four compounds mentioned. The gas chromatograms of the sample extracts were used to establish the presence of creosote. Typical chromatographs and conditions are presented later in this Appendix. Coincidence of retention times is the basis for this identification.

Three sediment samples were analyzed by a gas chromatograph mass spectrometer system. An extract from the river mud collected at mile 5.8 contained 15 compounds indicative of creosote.[14] Seventeen constituent compounds of creosote were found in the sediment from river mile 2.6 and the most weathered sample from river mile 1.5 contained seven polynuclear aromatic hydrocarbons indicative of creosotic materials. A summary of the mass spectrometry creosote identification is presented below.

APPENDIX C

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE LITTLE MENOMONEE RIVER, WISCONSIN

April 1977

PHYSICAL AND CHEMICAL CONDITIONS IN THE LITTLE MENOMONEE RIVER, MILWAUKEE, WISCONSIN*
April, 1977

Station R.M.	Date April	Time	Water Temperature °C	pH	Diss mg/l	Oxygen % Sat.
6.9	20	0945	14.5	7.8	11.5	110
	21	1030	13.5	7.5	7.5	70
	22	1115	11.0	7.8	12.0	110
	23	1435	15.0	7.9	12.5	120
	24	1210	11.0	7.8	12.0	110
6.0	20	0955	18.5	7.7	12.0	130
	21	1115	16.5	7.6	8.0	80
	22	1300	15.0	7.8	11.0	110
	23	1420	17.0	7.9	12.0	120
	24	1330	12.0	8.0	12.0	110
5.8	20	1005	16.5	7.6	8.0	80
	21	1125	15.0	7.6	8.5	85
	22	1345	14.0	7.8	10.0	95
	23	1410	16.5	7.8	11.0	110
	24	1335	12.0	8.0	13.0	120
5.1	20	1330	17.0	7.6	11.5	115
	21	1133	16.0	7.6	9.0	90
	22	1420	15.0	8.0	11.0	110
	23	1355	16.5	8.1	15.0	150
	24	1345	13.0	8.1	13.0	120
4.2	20	1030	17.0	7.8	11.0	110
	21	1150	15.0	7.6	9.5	95
	22	1515	14.5	8.1	12.0	120
	23	1335	15.5	8.2	13.5	135
	24	1445	12.5	8.3	13.0	120
2.6	20	1100	17.0	7.8	8.5	90
	21	1200	15.5	7.6	9.0	90
	22	1545	13.0	8.1	12.0	115
	23	1325	14.0	8.0	13.0	125
	24	1455	12.0	8.3	12.5	115
2.0	20	1400	19.9	7.7	15.0	160
	21	1206	15.5	7.6	9.5	95
	22	1545	14.0	8.1	12.0	115
	23	1310	15.0	8.0	13.0	130
	24	1500	12.5	8.2	12.0	110
1.0	20	1420	20.0	8.1	15.0	160
	21	1218	15.0	7.6	9.5	95
	22	1700	13.0	8.1	13.0	125
	23	1045	13.0	7.9	13.2	125
	24	1512	12.0	8.2	12.0	110
7.6	20	1430	20.0	8.5	15.0	160
	21	1235	16.5	7.6	8.0	80
	22	1720	14.0	8.4	13.0	125
	23	1145	15.0	7.8	13.0	130
	24	1520	13.0	8.3	11.0	105
7.5	20	1445	21.5	8.3	16.5	170
	21	1240	15.0	7.6	8.5	85
	22	1725	14.0	8.2	13.0	125
	23	1215	15.0	7.9	14.0	140
	24	1525	13.5	8.3	10.5	100

*Surface water samples.

SPECTROMETRY CREOSOTE IDENTIFICATION

Compound	Reference Sample 1: 0.3% Soln. Creosote Tank Kerr-McGee	Reference Sample 2: Creosote Recovery Tank Kerr-McGee	Reference Sample 3: Local Creosote with oil Diluent 0.5% Soln.†	Reference Sample 4: 0.5% Comm. Creosote-local No diluent oil	Extracts of Sediments from Little Menomonee River: Mile 5.8	Extracts of Sediments from Little Menomonee River: Mile 2.6	Extracts of Sediments from Little Menomonee River: Mile 1.5
Indene	CF††	CF	- †††	-	-	-	-
Naphthalene	CF	CF	CF	CF	CF	CF	-
Quinoline	CF	CF	-	CF	-	-	-
2-Methylnaphthalene	CF	CF	CF	CF	CF	CF	-
1-Methylnaphthalene	CF	CF	CF	CF	CF	CF	-
Biphenyl	CF	CF	CF	CF	CF	CF	-
Ethylnaphthalene	Fair*	-	Good*	-	-	Good*	-
Dimethylnaphthalene	Good*	Good*	Good*	-	Good*	Good*	-
1, 3-Dimethylnaphthalene	CF	CF	CF	CF	CF	CF	-
Acenaphthene	CF	CF	CF	CF	CF	CF	CF
Dibenzofuran	CF	CF	CF	CF	CF	CF	CF
Fluorene	CF	CF	CF	CF	CF	CF	CF
Dibenzothiophene	Good*	Good*	Good*	-	Good*	Good*	-
Anthracene	CF	CF	CF	CF	CF	CF	CF
(Phenanthrene)**	CF	CF	CF	CF	CF	CF	CF
Carbazole	CF	CF	CF	CF	-	-	-
2-Methylphenanthrene	Good*	Good*	Good*	Good*	Good*	Good*	-
4. 5-Methylene Phenanthrene	Good*	Good*	Fair*	-	-	Good*	-
Fluoranthene	CF	CF	CF	CF	CF	CF	CF
Pyrene	CF	CF	CF	CF	CF	CF	CF

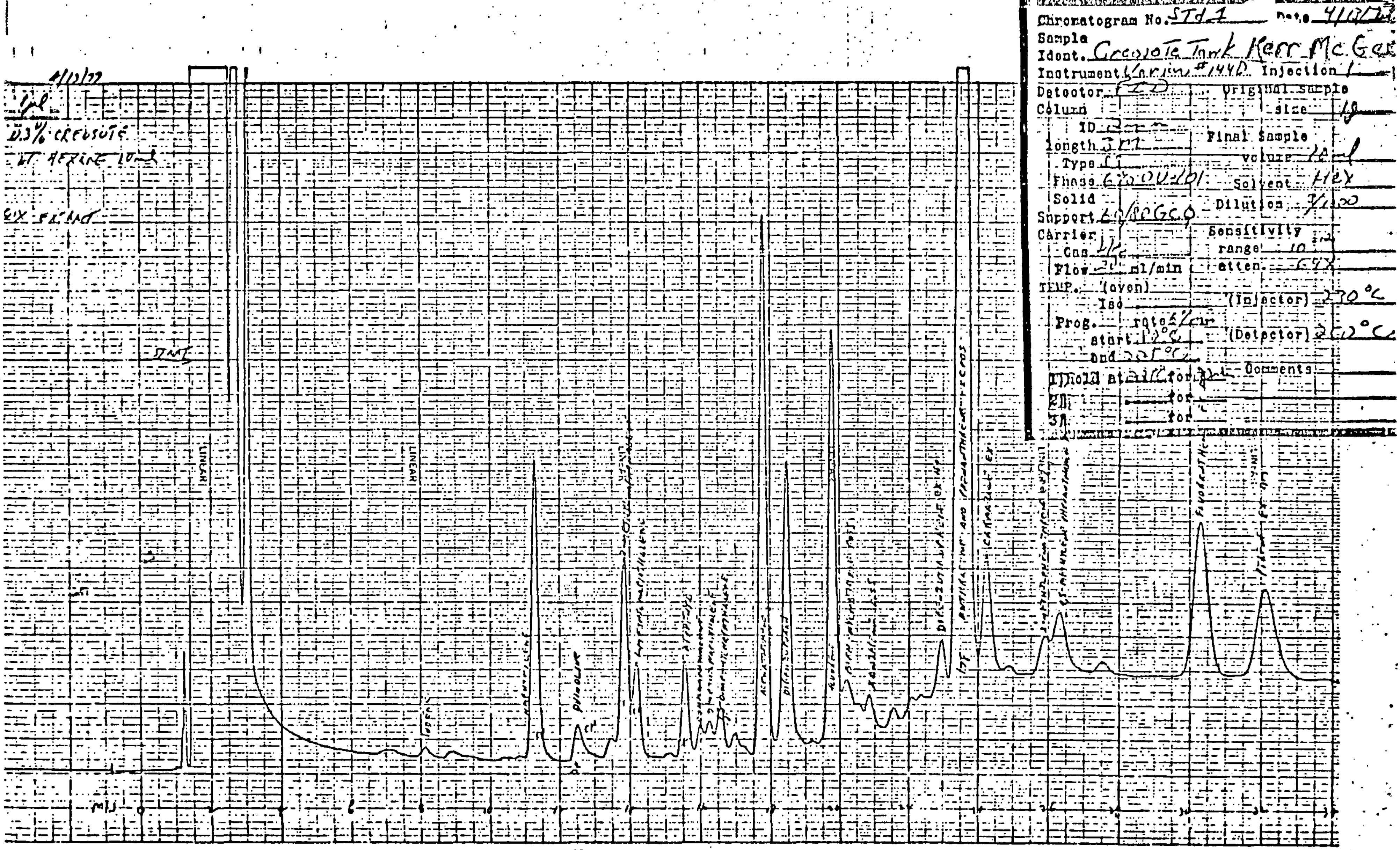
† *This sample contained numerous petroleum hydrocarbons both paraffins and olefins from a range of n C_9 - n C_{13} indicative of a light refined oil. These components for the most part eluted before the creosote components and did not interfere with the identification.*

†† *These compounds confirmed by GC/MS Ident, GC/MS of Stds, and confirmation of retention times with those of stds.*

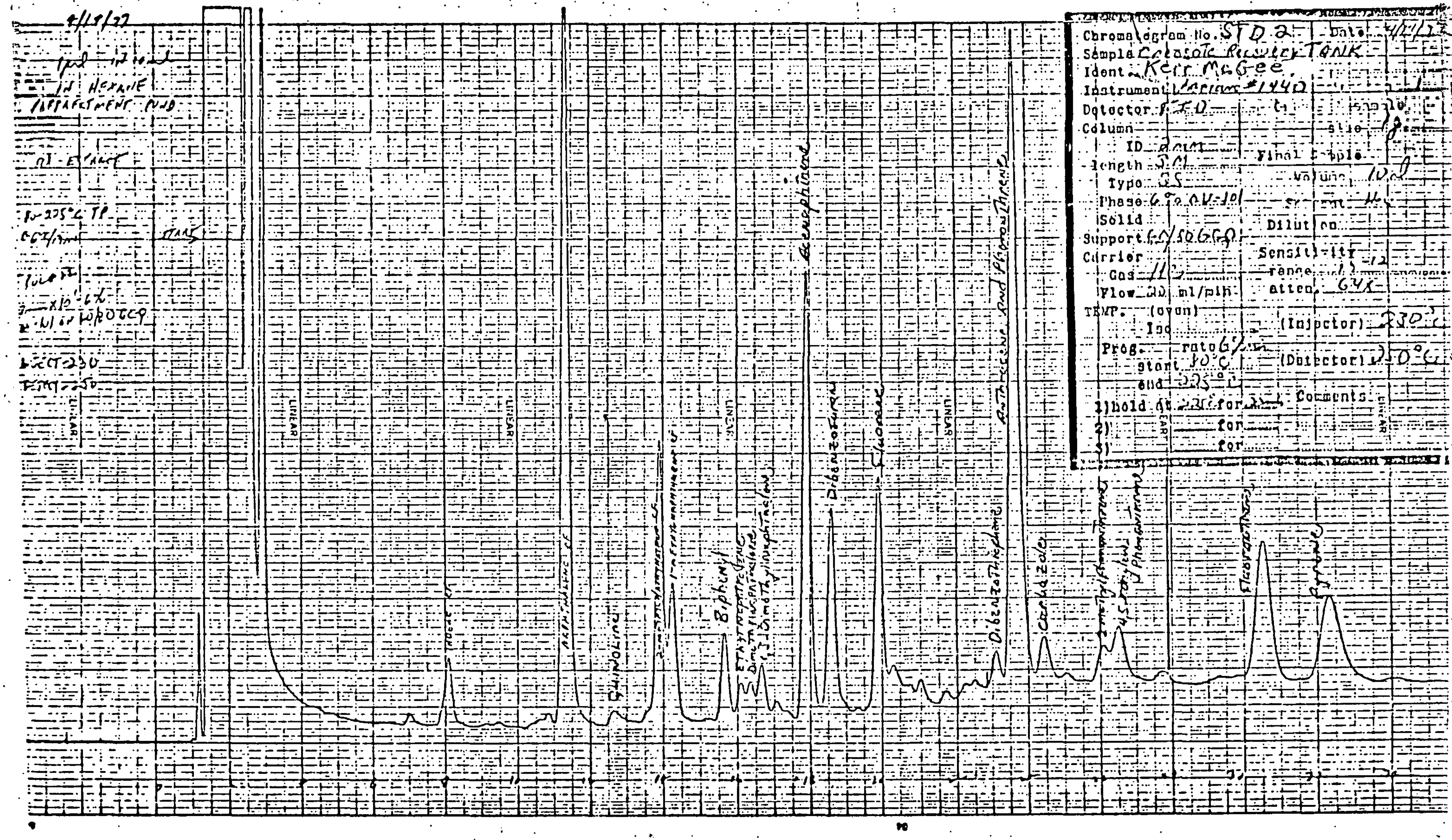
††† *Not detected.*

* *GC/MS identification only. No standards available at this time.*

** *Phenanthrene and anthracene have identical mass spectra, but the gas chromatography retention time of phenanthrene is a little longer than anthracene and with more dilute solutions a definite shoulder can be observed with the GC conditions used and both compounds are obviously present.*



Chromatogram No. STd 1
Date 4/13/79
Sample Ident. Creosote Tank Kerr McGee
Instrument Varian #1440
Injection 1
Detector FID
Original Sample size 1g
Column
Length 3m
Type
Phase
Final Sample volume 10 ml
Solvent HEX
Solid Support
Dilution
Carrier Gas
Flow ml/min
Sensitivity range 10
atten.
TEMP. (oven)
Iso
(Injector) 230 °C
Prog. rate
start
end
(Detector) 250 °C
Comments
1) Hold at
2)
3)
for
4/13/79
1μl
0.3% CREOSOTE
LINEAR
QUINOLINE
NAPHTHALENE
ACENAPHTHENE
DIBENZOFURAN
FLUORENE
FLUORANTHENE
PYRENE

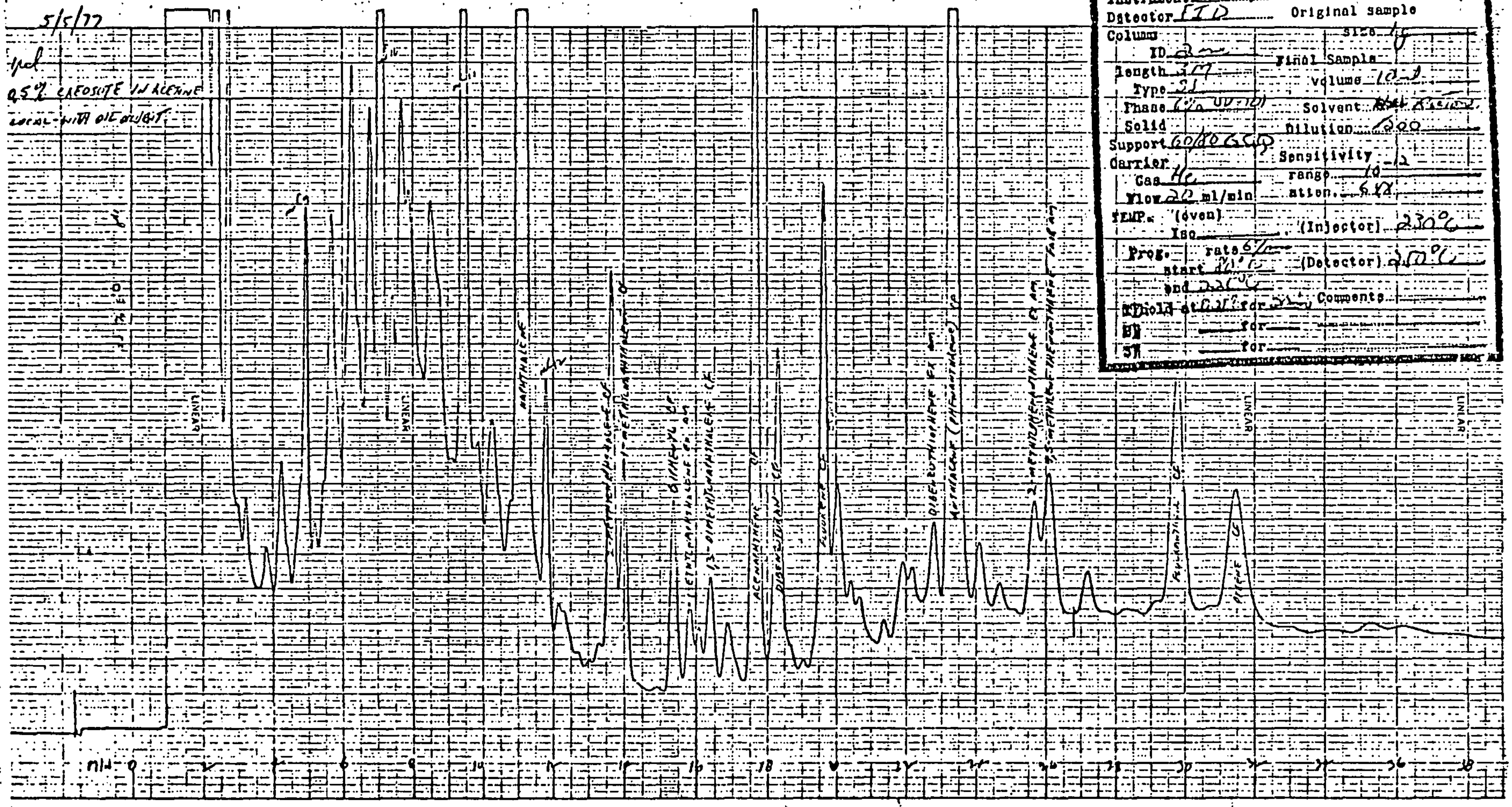

IN HEXANE
Chromatogram No. STD 2
Sample Creosote Recovery TANK
Ident. Kerr McGee
Instrument
Detector
Column
ID
Length
Type
Phase
Solid
Support
Carrier
Gas
Flow ml/min
Sensitivity
range
atten. 64X
TEMP. (oven)
Iso
Prog. rate
start
end
1) hold at
2) for
3) for
(Injector)
(Detector)
Comments
Final Sample
Volume
Dilution
LINEAR
Quinoline
Biphenyl
Acenaphthene
Dibenzofuran
Fluorene
Dibenzothiophene
Anthracene and Phenanthrene
Carbazole
Fluoranthene
Pyrene

5/5/77

1µl

0.5% CREOSOTE IN ACETONE

LOCAL-WITH OIL DILUENT



Chromatogram No. STD 3 Date 5/5/77

Sample Ident. Local Creosote with oil diluent

Instrument Varian #1440 Injection 1 µl

Detector FID Original sample size 1g

Column ID 2mm Final Sample

Length 3M volume 10ml

Type SS

Phase 2% OV-101 Solvent Acetone

Solid Dilution 1200

Support 60/80 GCQ

Carrier Sensitivity 2

Gas He range 10

Flow 20 ml/min atten. 64X

TEMP. (oven) Iso (Injector) 230°C

Prog. rate 6°/min (Detector) 250°C

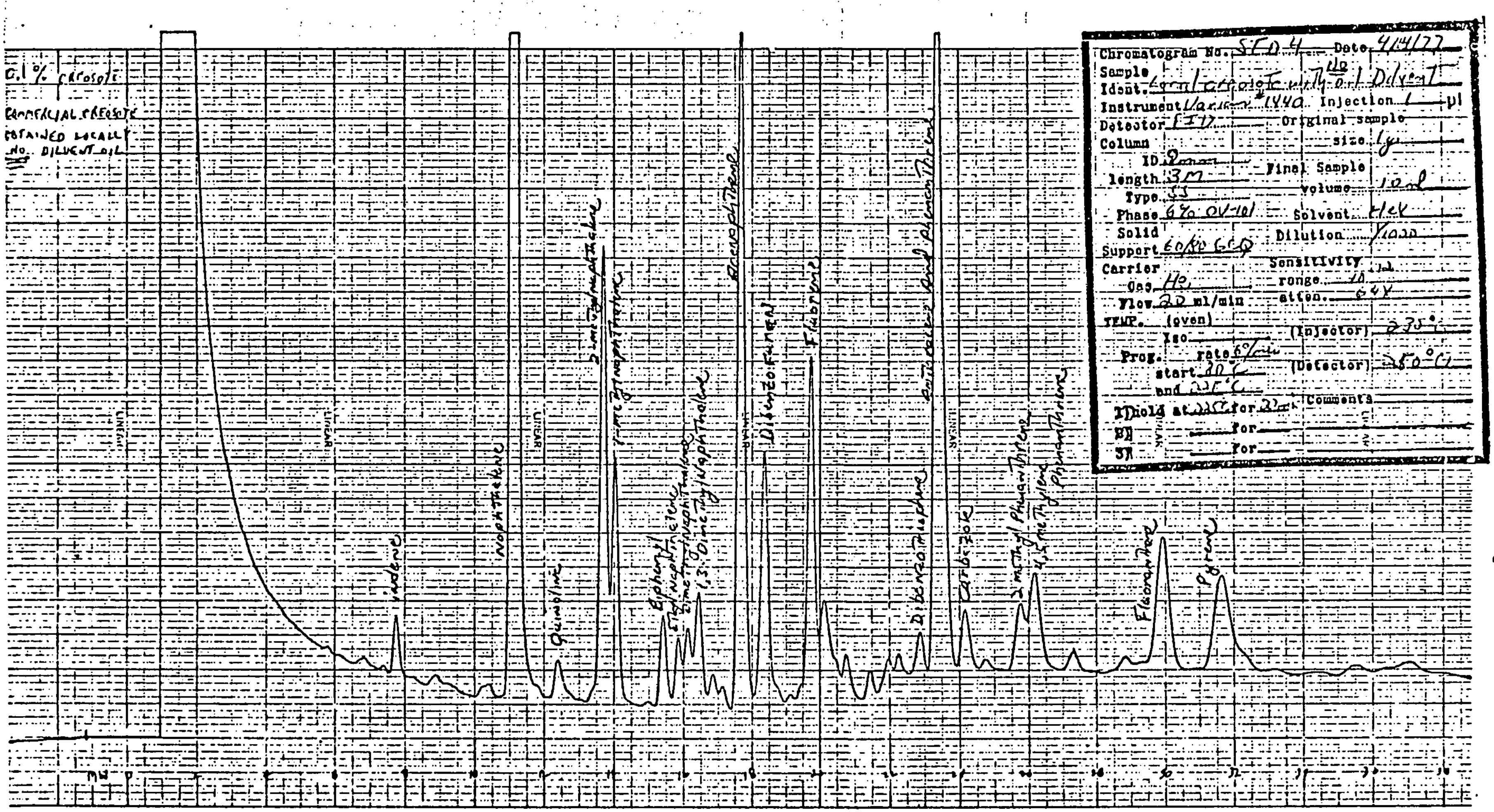
start 80°C

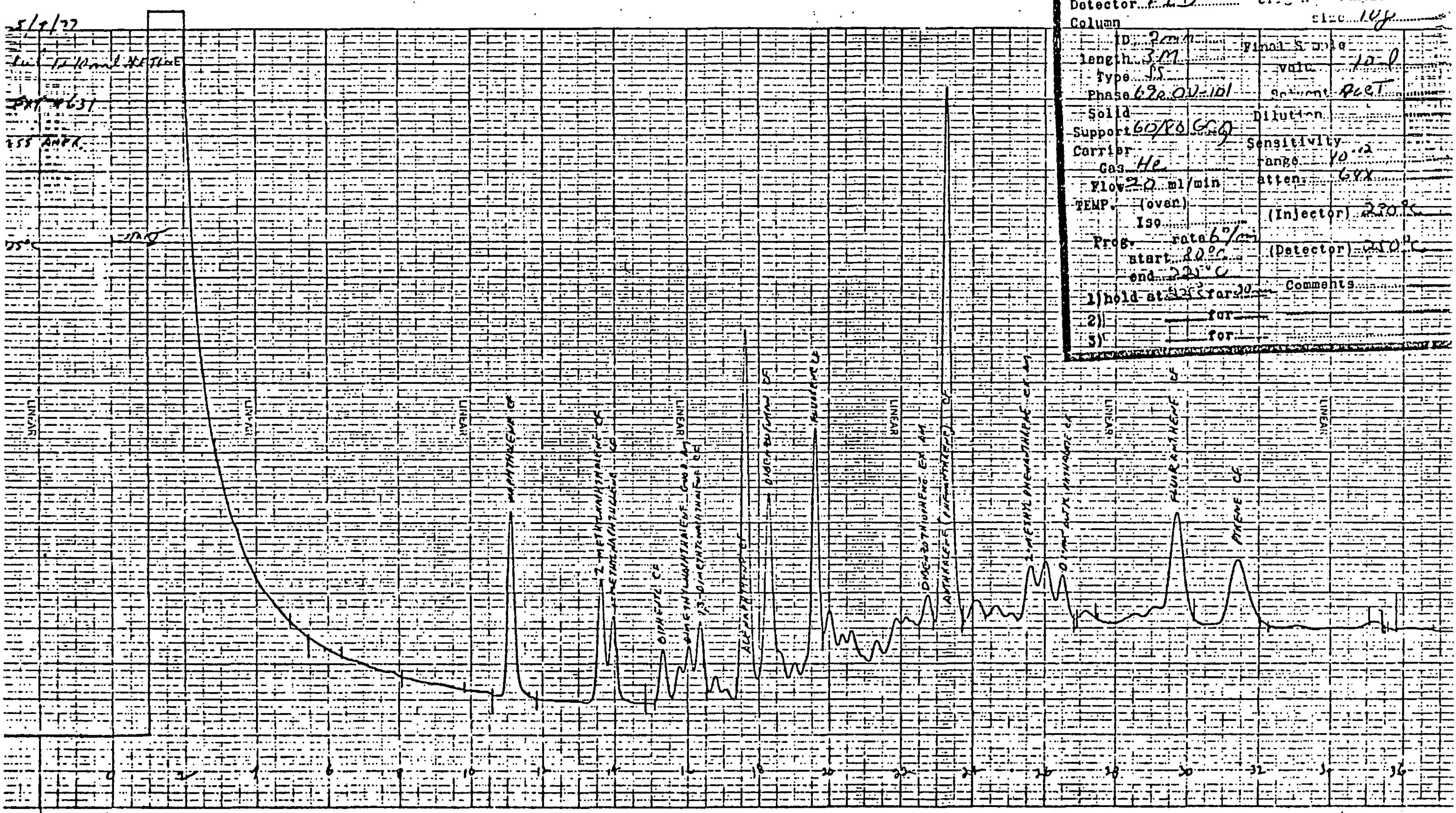
end 230°C

Hold at 230°C for 5 min Comments

for

for


0.1% creosote
COMMERCIAL CREOSOTE OBTAINED LOCALLY NO. DILUENT OIL
Chromatogram No. SED 4 Date 4/14/77
Sample Ident. Coal creosote with no oil Diluent
Instrument Varian #1440 Injection 1 μl
Detector FID
Original sample size 1g
Column ID 2mm
length 3M
Type SS
Phase 6% OV-101
Solid Support 60/80 GCQ
Final Sample volume 10 ml
Solvent Hex
Dilution 1/1000
Carrier Gas He
Flow 20 ml/min
Sensitivity
range 10
atten. 64X
TEMP. (oven)
Iso
Prog. rate 6°/min
start 80°C
end 235°C
Hold at 235°C for 20 min
(Injector) 235°
(Detector) 250°C
Comments
For
For
LINEAR
indene
Naphthalene
Quinoline
Biphenyl
Dibenzofuran
Fluorene
Carbazole
Fluoranthene
Pyrene



Chromatogram No. 631 Date 5/4/77

Sample Ident. 771421 L m R 50 yds [illegible] Kerr Mc-Gee

Instrument Varian #1440 Injection [illegible] µl

Detector FID Orig. of sample size 10 g

Column

ID 2mm Final Sample

length 3M vol. 10 ml

Type SS

Phase 6% OV-101 Solvent Acet

Solid Dilution

Support 60/80 GCQ

Carrier Sensitivity

Gas He range 10^{-12}

Flow 20 ml/min atten. 64X

TEMP. (oven) (Injector) 220°C

Iso

Prog. rate 6°/min (Detector) 250°C

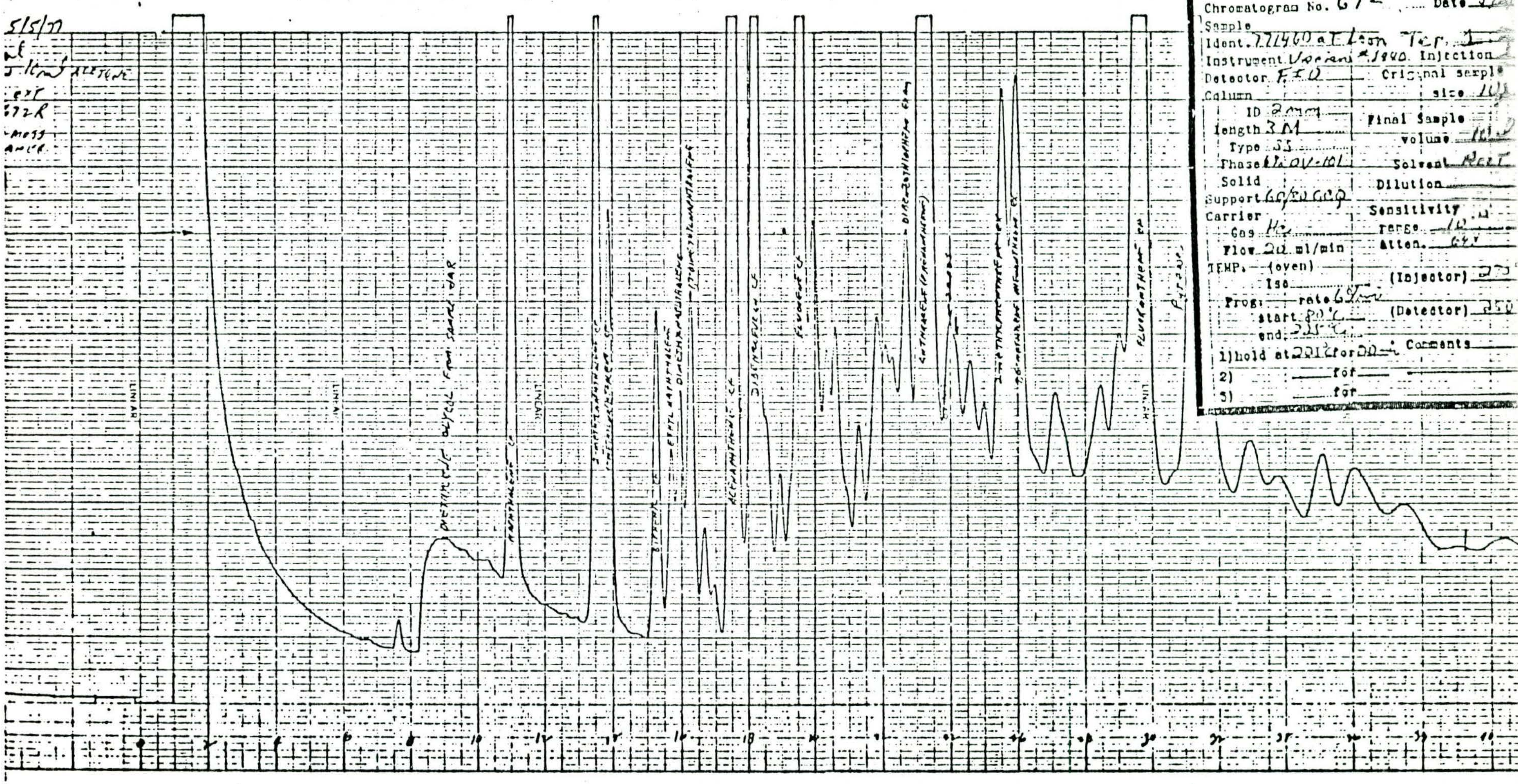
start 80°C

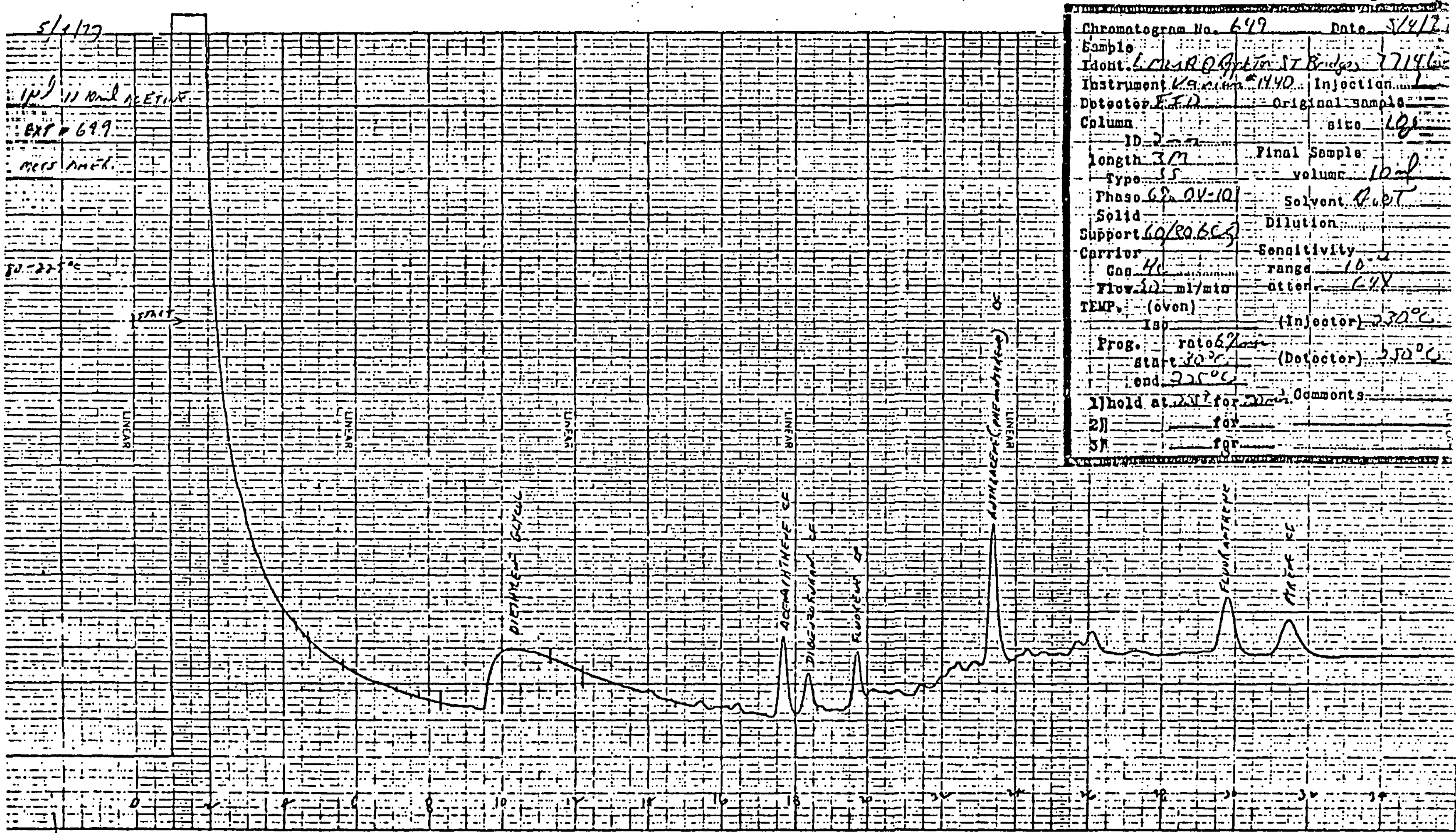
end 220°C

1) hold at 220 for 30 min Comments

2) for

3) for


Chromatogram No. 672
Date
Sample
Ident.
Instrument Varian #1840
Injection
Detector FID
Original sample size
Column
ID 2mm
Length 3M
Type SS
Phase 6% OV-101
Solid Support 60/80 GCQ
Final Sample volume
Solvent
Dilution
Carrier Gas He
Flow 20 ml/min
Sensitivity range
Atten.
TEMP. (oven)
Iso
(Injector)
Prog: rate
start 80°C
(Detector)
end
Comments
1) hold at
for
2) for
3) for
LINEAR
NAPHTHALENE
ACENAPHTHENE
DIBENZOFURAN
FLUORENE
FLUORANTHENE
PYRENE



5/4/79
1µl 11 10ml ACETONE
EXT # 649
MERS AMEN.
80-225°C
START
LINEAR
DIETHYLENE GLYCOL
ACENAPHTHENE
DIBENZOFURAN
FLUORENE
ANTHRACENE (PHENANTHRENE)
FLUORANTHENE
PYRENE
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
Chromatogram No. 649 Date 5/4/7
Sample Ident. LCHS R Q Upton ST Bridges 77146
Instrument Varian #1440 Injection 1
Detector FID Original Sample size 10g
Column ID 2mm
length 3M Final Sample volume 10ml
Type SS
Phase 6% OV-101 Solvent Acet
Solid Support 60/80 GCQ Dilution
Carrier Gas He Sensitivity range 10
Flow 30 ml/min atten 64X
TEMP. (oven) Iso (Injector) 230°C
Prog. rate 6°/min
start 80°C (Detector) 250°C
end 225°C
1) hold at 225° for 30min. Comments
2) for
3) for

APPENDIX D

CHAIN-OF-CUSTODY PROCEDURES

ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER

CHAIN OF CUSTODY PROCEDURES

June 1, 1975

GENERAL

The evidence gathering portion of a survey should be characterized by the minimum number of samples required to give a fair representation of the effluent or water body from which taken. To the extent possible, the quantity of samples and sample locations will be determined prior to the survey.

Chain of Custody procedures must be followed to maintain the documentation necessary to trace sample possession from the time taken until the evidence is introduced into court. A sample is in your "custody" if:

1. It is in your actual physical possession, or

2. It is in your view, after being in your physical possession, or

3. It was in your physical possession and then you locked it up in a manner so that no one could tamper with it.

All survey participants will receive a copy of the survey study plan and will be knowledgeable of its contents prior to the survey. A pre-survey briefing will be held to re-appraise all participants of the survey objectives, sample locations and Chain of Custody procedures. After all Chain of Custody samples are collected, a de-briefing will be held in the field to determine adherence to Chain of Custody procedures and whether additional evidence type samples are required.

SAMPLE COLLECTION

1. To the maximum extent achievable, as few people as possible should handle the sample.

2. Stream and effluent samples shall be obtained, using standard field sampling techniques.

3. Sample tags (Exhibit I) shall be securely attached to the sample container at the time the complete sample is collected and shall contain, at a minimum, the following information: station number, station location, data taken, time taken, type of sample, sequence number (first sample of the day - sequence No. 1, second sample - sequence No. 2, etc.), analyses required and samplers. The tags must be legibly filled out in ballpoint (waterproof ink).

4. Blank samples shall also be taken with preservatives which will be analyzed by the laboratory to exclude the possibility of container or preservative contamination.

5. A pre-printed, bound Field Data Record logbook shall be maintained to record field measurements and other pertinent information necessary to refresh the sampler's memory in the event he later takes the stand to testify regarding his actions during the evidence gathering activity. A separate set of field notebooks shall be maintained for each survey and stored in a safe place where they could be protected and accounted for at all times. Standard formats (Exhibits II and III) have been established to minimize field entries and include the date, time, survey, type of samples taken, volume of each sample, type of analysis, sample numbers, preservatives, sample location and field measurements such as temperature, conductivity,

DO, pH, flow and any other pertinent information or observations. The entries shall be signed by the field sampler. The preparation and conservation of the field logbooks during the survey will be the responsibility of the survey coordinator. Once the survey is complete, field logs will be retained by the survey coordinator, or his designated representative, as a part of the permanent record.

6. The field sampler is responsible for the care and custody of the samples collected until properly dispatched to the receiving laboratory or turned over to an assigned custodian. He must assure that each container is in his physical possession or in his view at all times, or locked in such a place and manner that no one can tamper with it.

7. Colored slides or photographs should be taken which would visually show the outfall sample location and any water pollution to substantiate any conclusions of the investigation. Written documentation on the back of the photo should include the signature of the photographer, time, date and site location. Photographs of this nature, which may be used as evidence, shall be handled recognizing Chain of Custody procedures to prevent alteration.

TRANSFER OF CUSTODY AND SHIPMENT

1. Samples will be accompanied by a Chain of Custody Record which includes the name of the survey, samplers' signatures, station number, station location, date, time, type of sample, sequence number, number of containers and analyses required (Fig. IV). When turning over the possession of samples, the transferor and transferee will sign, date and time the sheet. This record sheet allows transfer of custody of a group of samples in the field, to the mobile laboratory or when samples are dispatched to the NEIC - Denver laboratory. When transferring a portion of the samples identified on the sheet to the field mobile laboratory, the individual samples must be noted in the column with the signature of the person relinquishing the samples. The field laboratory person receiving the samples will acknowledge receipt by signing in the appropriate column.

2. The field custodian or field sampler, if a custodian has not been assigned, will have the responsibility of properly packaging and dispatching samples to the proper laboratory for analysis. The "Dispatch" portion of the "Chain of Custody Record shall be properly filled out, dated, and signed.

3. Samples will be properly packed in shipment containers such as ice chests, to avoid breakage. The shipping containers will be padlocked for shipment to the receiving laboratory.

4. All packages will be accompanied by the Chain of Custody Record showing identification of the contents. The original will accompany the shipment, and a copy will be retained by the survey coordinator.

5. If sent by mail, register the package with return receipt requested. If sent by common carrier, a Government Bill of Lading should be obtained. Receipts from post offices, and bills of lading will be retained as part of the permanent Chain of Custody documentation.

6. If samples are delivered to the laboratory when appropriate personnel are not there to receive them, the samples must be locked in a designated area within the laboratory in a manner so that no one can tamper with them. The same person must then return to the laboratory and unlock the samples and deliver custody to the appropriate custodian.

LABORATORY CUSTODY PROCEDURES

1. The laboratory shall designate a "sample custodian." An alternate will be designated in his absence. In addition, the laboratory shall set aside a "sample storage security area." This should be a clean, dry, isolated room which can be securely locked from the outside.

2. All samples should be handled by the minimum possible number of persons.

3. All incoming samples shall be received only by the custodian, who will indicate receipt by signing the Chain of Custody Sheet accompanying the samples and retaining the sheet as permanent records. Couriers picking up samples at the airport, post office, etc. shall sign jointly with the laboratory custodian.

4. Immediately upon receipt, the custodian will place the sample in the sample room, which will be locked at all times except when samples are removed or replaced by the custodian. To the maximum extent possible, only the custodian should be permitted in the sample room.

5. The custodian shall ensure that heat-sensitive or light-sensitive samples, or other sample materials having unusual physical characteristics, or requiring special handling, are properly stored and maintained.

6. Only the custodian will distribute samples to personnel who are to perform tests.

7. The analyst will record in his laboratory notebook or analytical worksheet, identifying information describing the sample, the procedures performed and the results of the testing. The notes shall be dated and indicate who performed the tests. The notes shall be retained as a permanent record in the laboratory and should note any abnormalties which occurred during the testing procedure. In the event that the person who performed the tests is not available as a witness at time of trial, the government may be able to introduce the notes in evidence under the Federal Business Records Act.

8. Standard methods of laboratory analyses shall be used as described in the "Guidelines Establishing Test Procedures for Analysis of Pollutants," 38 F.R. 28758, October 16, 1973. If laboratory personnel deviate from standard procedures, they should be prepared to justify their decision during cross-examination.

9. Laboratory personnel are responsible for the care and custody of the sample once it is handed over to them and should be prepared to testify that the sample was in their possession and view or secured in the laboratory at all times from the moment it was received from the custodian until the tests were run.

10. Once the sample testing is completed, the unused portion of the sample together with all identifying tags and laboratory records, should be returned to the custodian. The returned tagged sample will be retained in the sample room until it is required for trial. Strip charts and other documentation of work will also be turned over to the custodian.

11. Samples, tags and laboratory records of tests may be destroyed only upon the order of the laboratory director, who will first confer with the Chief, Enforcement Specialist Office, to make certain that the information is no longer required or the samples have deteriorated.

EXHIBIT I

★GPO IMPRINT

EPA, NATIONAL ENFORCEMENT INVESTIGATIONS CENTER

Station No.	Date	Time	Sequence No.

Station Location

_______ Grab
_______ Comp.

_______ BOD
_______ Solids
_______ COD
_______ Nutrients

_______ Metals
_______ Oil and Grease
_______ D.O.
_______ Bact.
_______ Other

Remarks/Preservative:

Samplers:

Front

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
BUILDING 53, BOX 25227, DENVER FEDERAL CENTER
DENVER, COLORADO 80225

Back

EXHIBIT II

ƆR ______________________________ SURVEY, PHASE______, DATE ______________

'PE OF SAMPLE______________________

STATION NUMBER	STATION DESCRIPTION	TOTAL VOLUME	TYPE CONTAINER	PRESERVATIVE	ANALYSES REQUIRED																			
					NUTRIENTS	BOD	COD	TOC	TOTAL SOLIDS	SUSPENDED SOLIDS	ALKALINITY	DO	pH*	CONDUCTIVITY*	TEMPERATURE*	TOTAL COLIFORM	FECAL COLIFORM	TURBIDITY	OIL AND GREASE	METALS	BACTI	PESTICIDES	HERB	TRACE ORGANICS

ꞮMARKS

EXHIBIT III

Samplers: ______________________

FIELD DATA RECORD

STATION	NUMBER	DATE	TIME	TEMPERATURE °C	CONDUCTIVITY μmhos/cm	pH S.U.	D.O. mg/l	Gage Ht. or Flow Ft. or CFS

ENVIRONMENTAL PROTECTION AGENCY
Office Of Enforcement
NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
Building 53, Box 25227, Denver Federal Center
Denver, Colorado 80225

CHAIN OF CUSTODY RECORD

SURVEY	SAMPLERS: *(Signature)*

STATION NUMBER	STATION LOCATION	DATE	TIME	SAMPLE TYPE: Water Comp.	SAMPLE TYPE: Water Grab.	SAMPLE TYPE: Air	SEQ. NO.	NO. OF CONTAINERS	ANALYSIS REQUIRED

Relinquished by: *(Signature)*		Received by: *(Signature)*	Date/Time
Relinquished by: *(Signature)*		Received by: *(Signature)*	Date/Time
Relinquished by: *(Signature)*		Received by: *(Signature)*	Date/Time
Relinquished by: *(Signature)*		Received by Mobile Laboratory for field analysis: *(Signature)*	Date/Time
Dispatched by: *(Signature)*	Date/Time	Received for Laboratory by:	Date/Time
Method of Shipment:			

Distribution: Orig. — Accompany Shipment
1 Copy — Survey Coordinator Field Files

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