W
3/27/81

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BRIAN E PALMER
MICHAEL T WESTERMEYER
JEROME P GILLIGAN
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JAMES D ALT

OF COUNSEL
WALDO F MARQUART
JOHN F FINK

March 27, 1981

RECEIVED
[illegible] 1981
ATTORNEY GENERAL

Stephen Shakman, Esq.
Minnesota Pollution Control Agency
1935 W. County Road B2
Roseville, Minnesota 55113

Dear Steve:

In accordance with our conversation, I am herewith enclosing for you, and I am also simultaneously sending to Tom Berg and Allen Hinderaker, a xerox copy of the transparencies that were used at the October 9, 1980 meeting. If, for any reason, you desire a set in transparency form, please call my secretary and she will get you a set.

Yours very truly,

Edward J. Schwartzbauer

EJS:ml

cc: Thomas Berg, Esq.
Allen Hinderaker, Esq.
Robert Polack, Esq.
Thomas E. Reiersgord, Esq.

US EPA RECORDS CENTER REGION 5
514094

007297

PUMPAGE AND PAH DATA FOR ST. LOUIS PARK MUNICIPAL WELLS

Well No.	1976-79 Average Pumpage MGD(a)	Design Pumpage(b) gpm (MGD)	Peak Demand Pumpage, % of Design(b)	Results of Recent (10/79 to 3/80) PAH Analyses, ng/l (ppt) Total PAH(c)	W.H.O. List(d)	No. of Analyses	Iron Removal Treatment(f)
				St. Peter Aquifer Wells			
3	0.23	1200(1.7)	71	66-305	<32	1	Yes
				Prairie-Du-Chien - Jordan Aquifer Wells			
4*	0.19	1200(1.7)	62	73-1170	2-70	21	No
5	0.15	1200(1.7)	121	10-280	5-32	1	No
6	1.11	1200(1.7)	104	8-320	<32	16	Yes
7*	0.04	1200(1.7)	93	205-450	<53	4	No
8	1.02	1050(1.5)	95	<280	<32	2	Yes
9*	0.04	1200(1.7)	94	<260	<53	1	No
10*	0.14	1000(1.4)	50	2540-4670	750-880	2	Yes
14	0.14	800(1.2)	100	40-180	6-20	4	Yes
15*	0.50	1200(1.7)	43	2100-5610	190-910	8	Yes
16	1.19	1100(1.6)	NA	4-280	<32	2	Yes
				Mt. Simon - Hinckley Aquifer Wells			
11	0.99	1200(1.7)	83	5-720	5-41	3	Yes
12	0.29	1500(2.2)	83	70-290	<32	2	Yes
13	0.21	1500(2.2)	64	5-270	<36	4	Yes
Total	5.87(e)	16,550(23.8)			33-125(g) (110-340)	71	

*Indicates wells which are currently shutdown due to elevated PAH levels.

(a) From SLP H&C Memo No. 80-08, 1/18/80.
(b) From Water System Study for St. Louis Park, Minnesota by Orr, Schelen, Mayeron & Assoc., 11/76.
(c) Sum of anywhere from 11 to 20 specific PAHs. Upper bound results from assigning a concentration equal to the detection limit for results reported below detection. Lower bound results by assigning a concentration of zero to results reported below detection.
(d) Sum of fluoranthene, benzo(a)pyrene, benzo(k)fluoranthene, benzo(g,h,i) perylene, and o-phenylenepyrene. The sixth and final chemical on the W.H.O. list - benzo(b)fluoranthene - was not analyzed.
(e) Total average pumpage shown is not the same as the sum of individual average values (6.24 MGD) because averages for wells 7, 9, 10 and 15 are for 1976-78 only.
(f) Iron removal treatment consists of aeration followed by high pressure sand filtration. All wells have chlorination and fluoridation treatment.
(g) Weighted average concentration of W.H.O. list PAHs in all wells based on minimum and maximum possible concentration in each well. Values in parentheses are min. and max. weighted average W.H.O. list PAH concentrations at station no. 1 (wells 3, 10, 11 and 15).

007298

007299

CONCENTRATIONS IN SELECTED PAHs IN
VARIOUS RAW AND TREATED DRINKING WATERS, ng/liter

Compound	NAS Carcinogenicity Rating	Effect of Standard Treatment Practices[a]: Pittsburgh, PA Monongahela R. Raw	Trt'd	Percent Removal	Philadelphia, PA Delaware R. Raw	Trd'd	Removal	Measured in Various Finished Drinking Waters: Avg. of 10 Different U.S. Locations(b)	Mpls.[c]	St. Paul[c]
Fluoranthene	-	408	ND	100	114	8.9	92	5.4±3.3(3)	9.3	4.7
Benzo(j)fluoranthene	++	36	0.3	99	43	ND	100	0.4±0.4(6)	-	-
Benzo(k)fluoranthene	++	19	0.2	99	33	ND	100	0.3±0.2(7)	-	-
Benzo(a)pyrene	+++	42	0.4	99	41	0.3	99	0.5±0.4(10)	< 3.6	< 3.6
o-Phenylenepyrene	+	60	1.2	98	72	1.7	98	1.3±0.5(7)	< 1.7	< 1.7
Benzo(g,h,i)perylene	-	34	0.7	98	48	4.0	92	1.9±1.2(9)	< 13	< 13
Treatment Steps Employed:		Lime, ferric sulfate addition, activated carbon addition (2 stages: powdered and granular carbon), chlorination, and fluoridation.			Ferric chloride, lime, activated carbon, ammonia addition, chlorination, and fluoridation.					

* Compound on W.H.O. recommended drinking water PAH limit list.

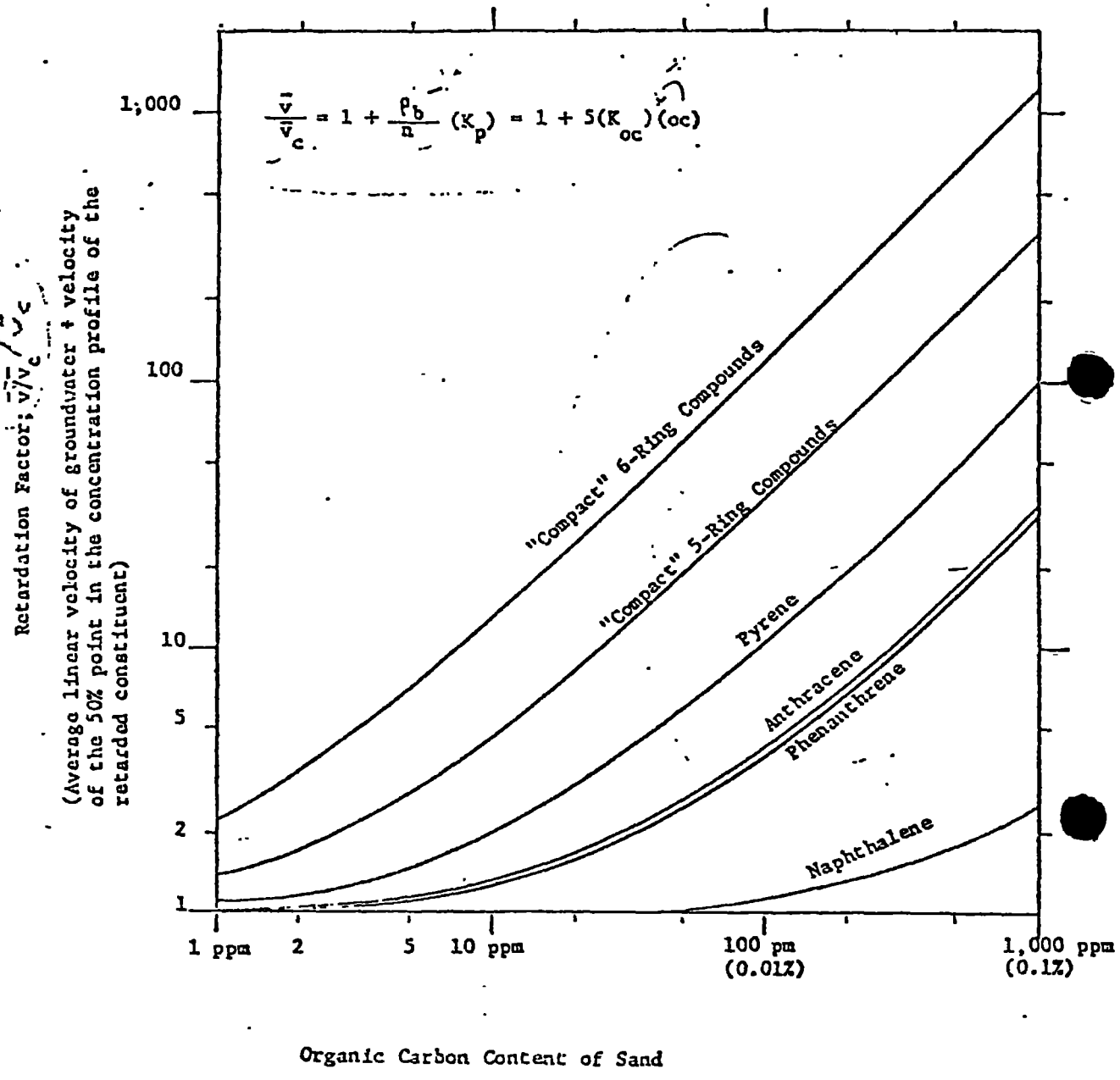
(a) Basu, D.K. and J. Saxena, ES&T 12(7):795-798, 1978.

(b) Mean ± standard deviation for samples with measurable levels obtained from (n) different water systems. From Basu & Saxena, 1978.

(c) From MDH report "Health Implications of Polynuclear Aromatic Hydrocarbons in St. Louis Park Drinking Water," Nov. 1978.

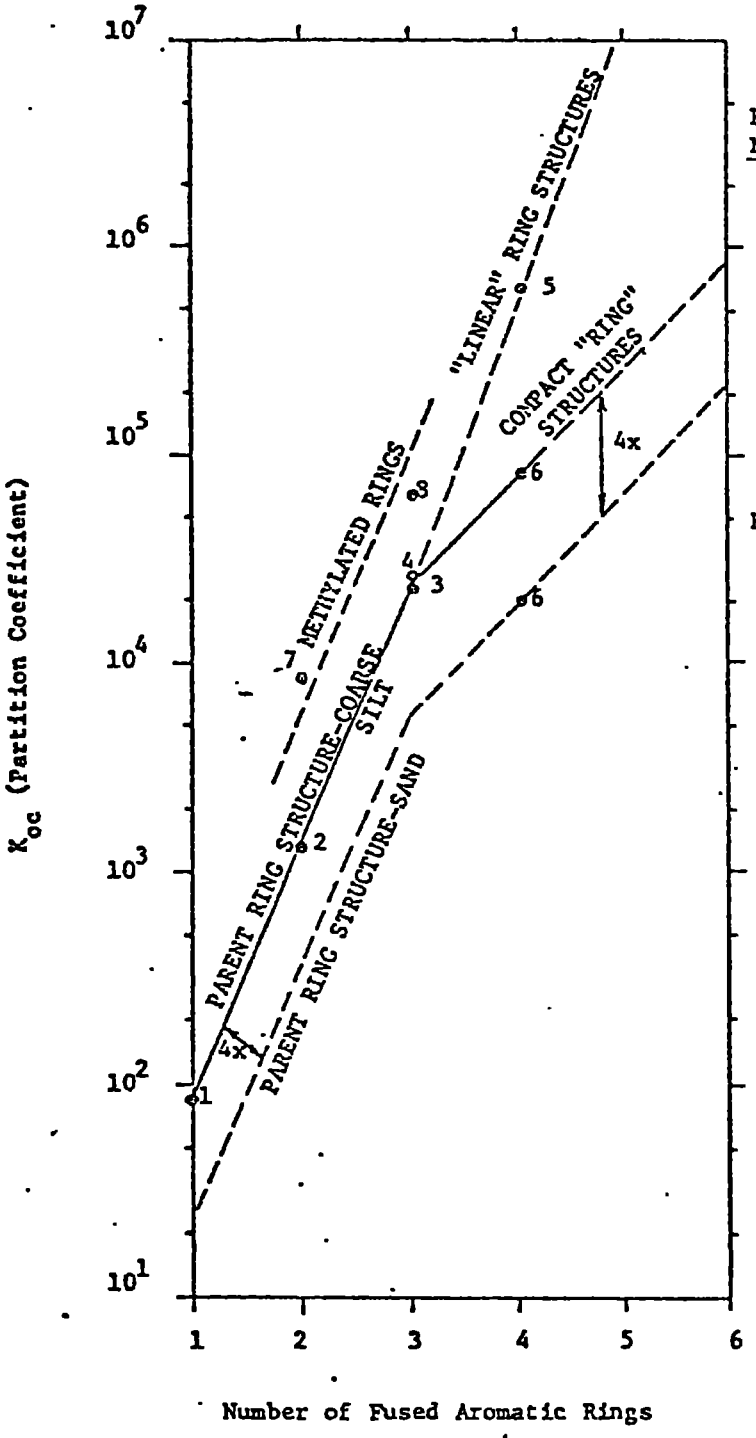
007300

FLOW RETARDATION FACTORS DUE TO SORPTION FOR VARIOUS PAHs



(Based on discussion in Freeze, R. A. and J. A. Cherry, Groundwater, Prentice-Hall, 1979, Ch. 9)

WATER/SEDIMENT PARTITION COEFFICIENTS FOR VARIOUS PAHs



Point Number	Compound
1	Benzene
2	Naphthalene
3	Phenanthrene
4	Anthracene
5	Tetracene
6	Pyrene
7	2-Methylnaphthalene
8	9-Methylanthracene

Reference:

Karickhoff, S. W., D. S. Brown, and T. A. Scott, Water Research 13: 241-248, 1979.

$$K_{oc} = K_p/oc$$

$$X = K_p C$$

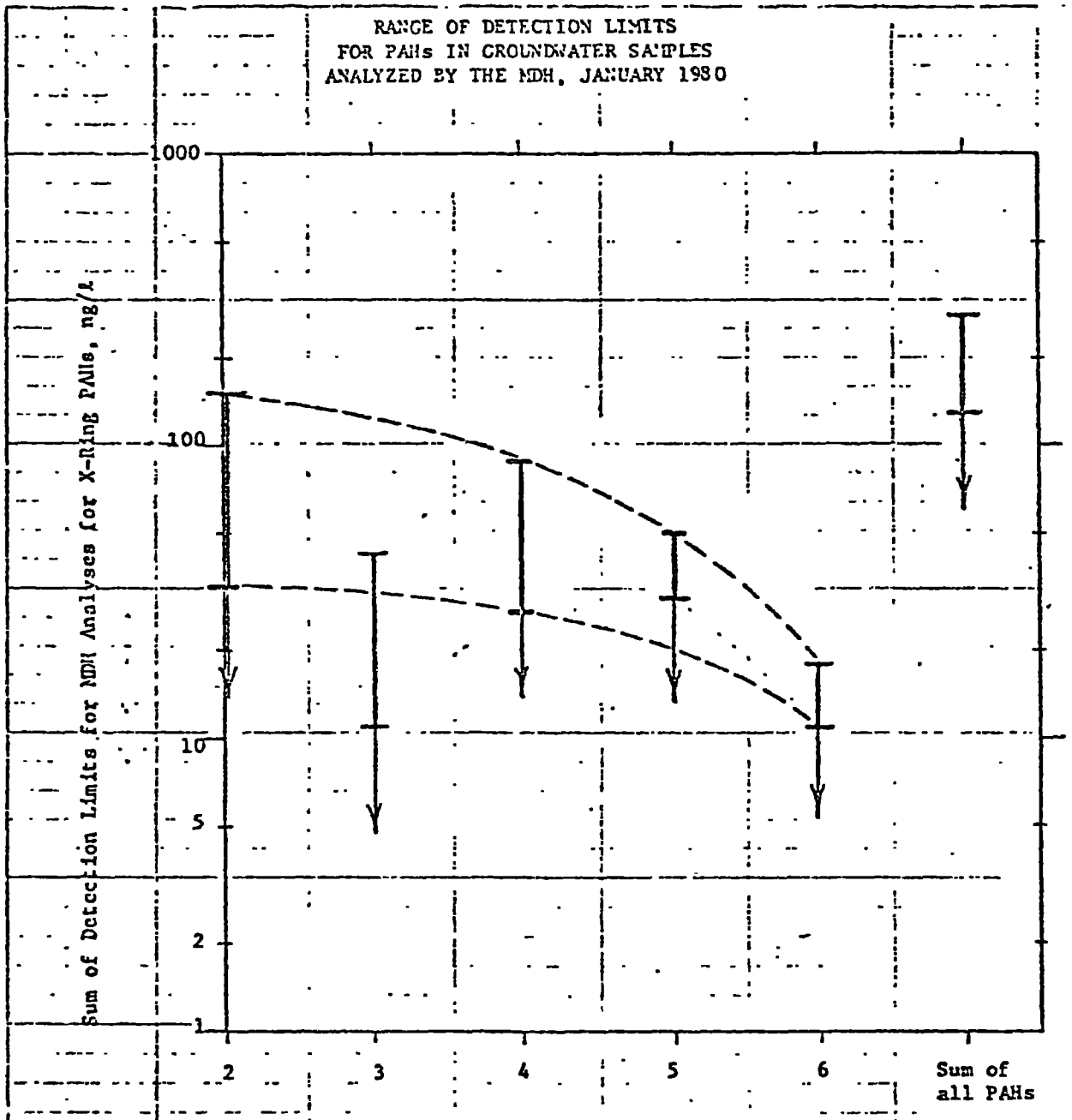
Where:

oc = fractional mass of organic carbon in sediment

X = concentration of sorbate on the sediment (ppb dry wt. basis)

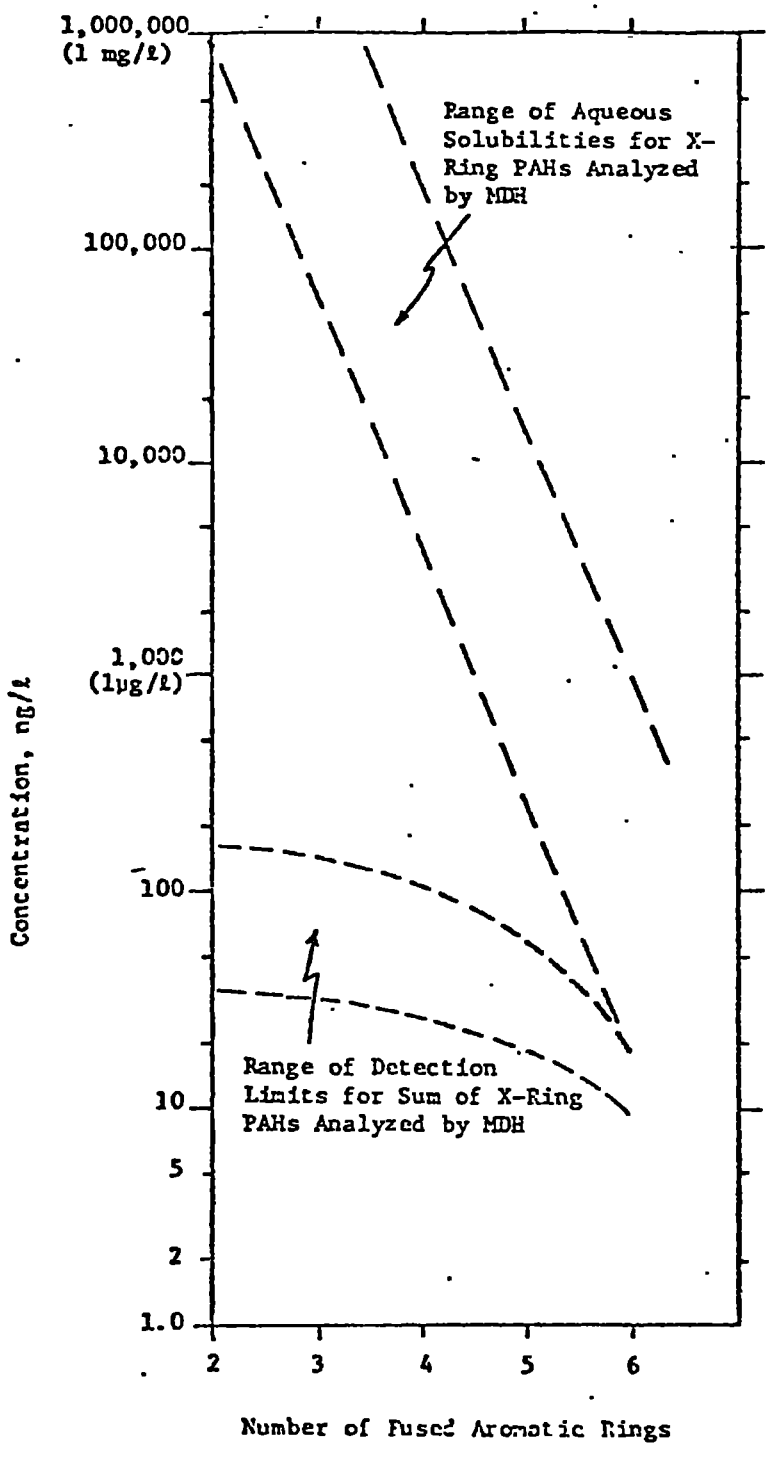
C = equilibrium solution sorbate concentration (ppb)

007301


RANGE OF DETECTION LIMITS
FOR PAHs IN GROUNDWATER SAMPLES
ANALYZED BY THE MDH, JANUARY 1980
Sum of Detection Limits for MDH Analyses for X-Ring PAHs, ng/L
1000
100
10
5
2
1
2
3
4
5
6
Sum of all PAHs
Number of Fused Aromatic Rings (x)

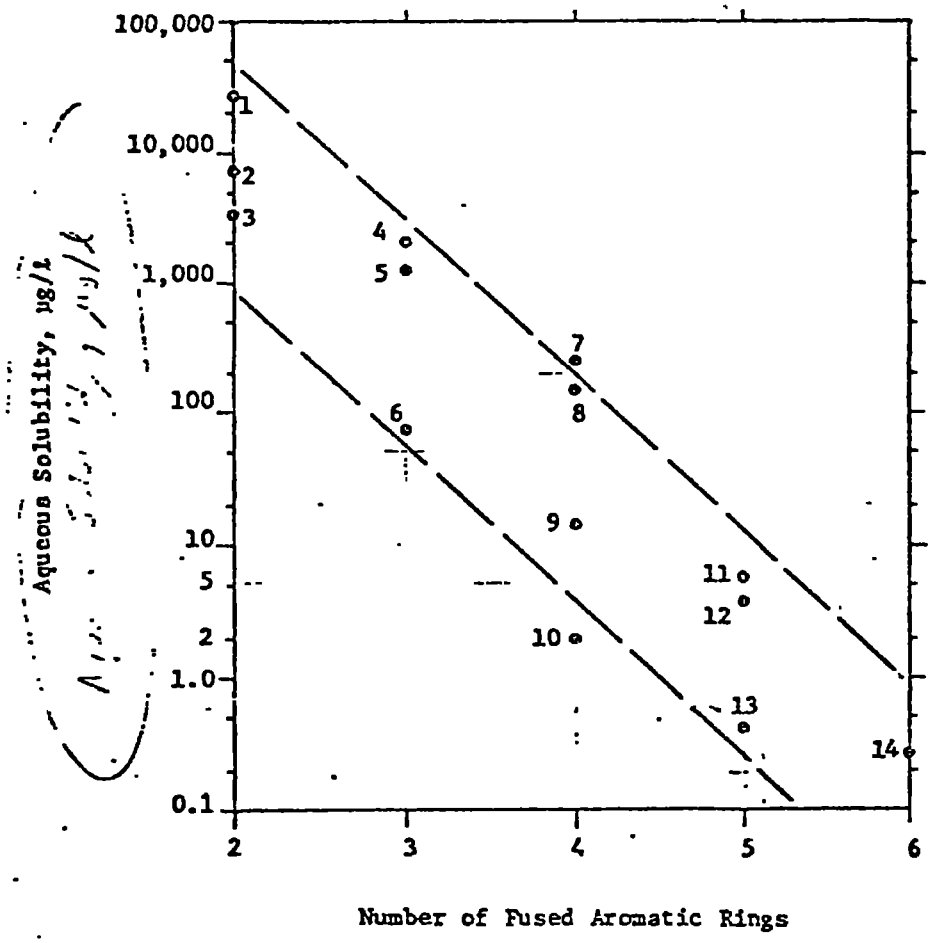
007302

AQUEOUS SOLUBILITIES AND DETECTION LIMITS FOR PAHs ANALYZED BY MDH



007303

AQUEOUS SOLUBILITIES OF PAHs
ANALYZED BY MDH IN GROUNDWATER SAMPLES



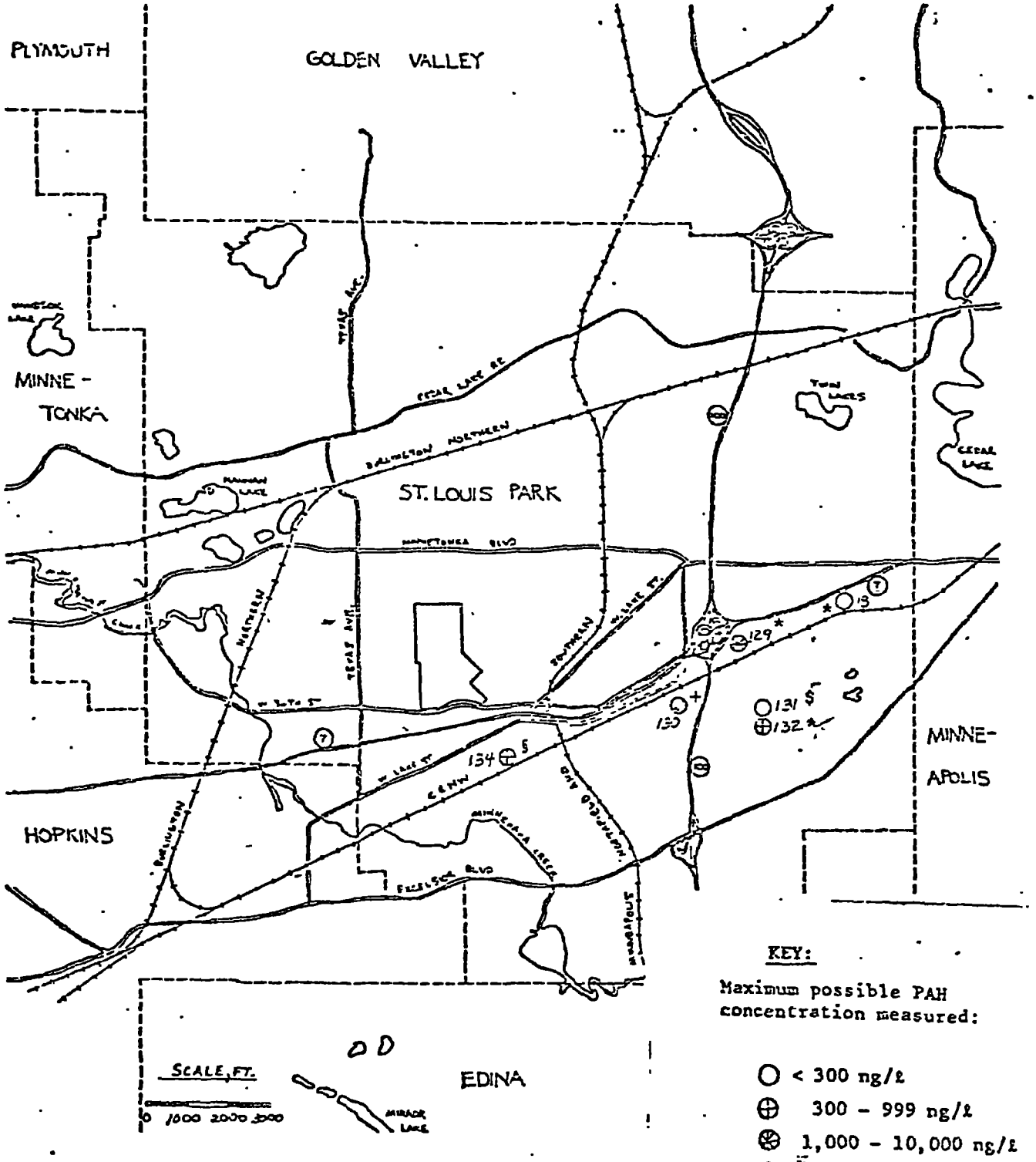
Point No.	Compound	Ref.	Point No.	Compound	Ref.
1	1-Methylnaphthalene	2	8	Pyrene	1
2	Biphenyl	2	9	Benz(a)anthracene	1
3	Acenaphthene	2	10	Chrysene	1
4	Fluorene	1	11	Benz(e)pyrene	2
5	Phenanthrene	1	12	Benz(a)pyrene	1
6	Anthracene	1	13	Perylene	1
7	Fluoranthene	1	14	Benzo(ghi)perylene	1

References:

(1) MacKay, D. and W. Y. Shiu, J. Chem. Eng. Data, 22: 399-402, 1977.

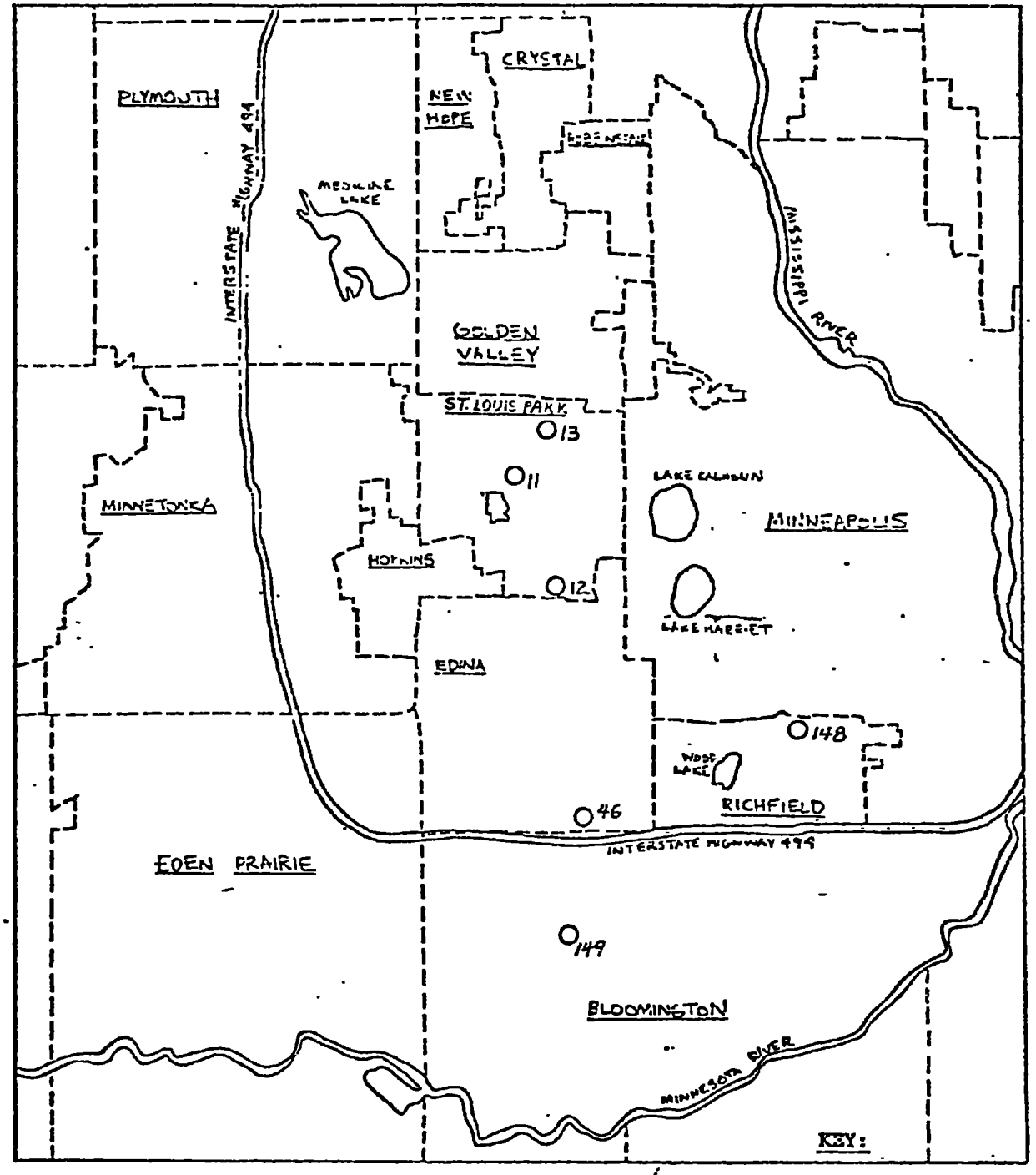
(2) USGS, Draft Open File report on SLP Groundwater Contamination Studies, 1979, Figure 35.

LOCATION OF MULTIAQUIFER WELLS ANALYZED FOR PAH



007305

LOCATION OF WELLS IN THE MOUNT SIMON-HINCKLEY AQUIFER ANALYZED FOR PAH



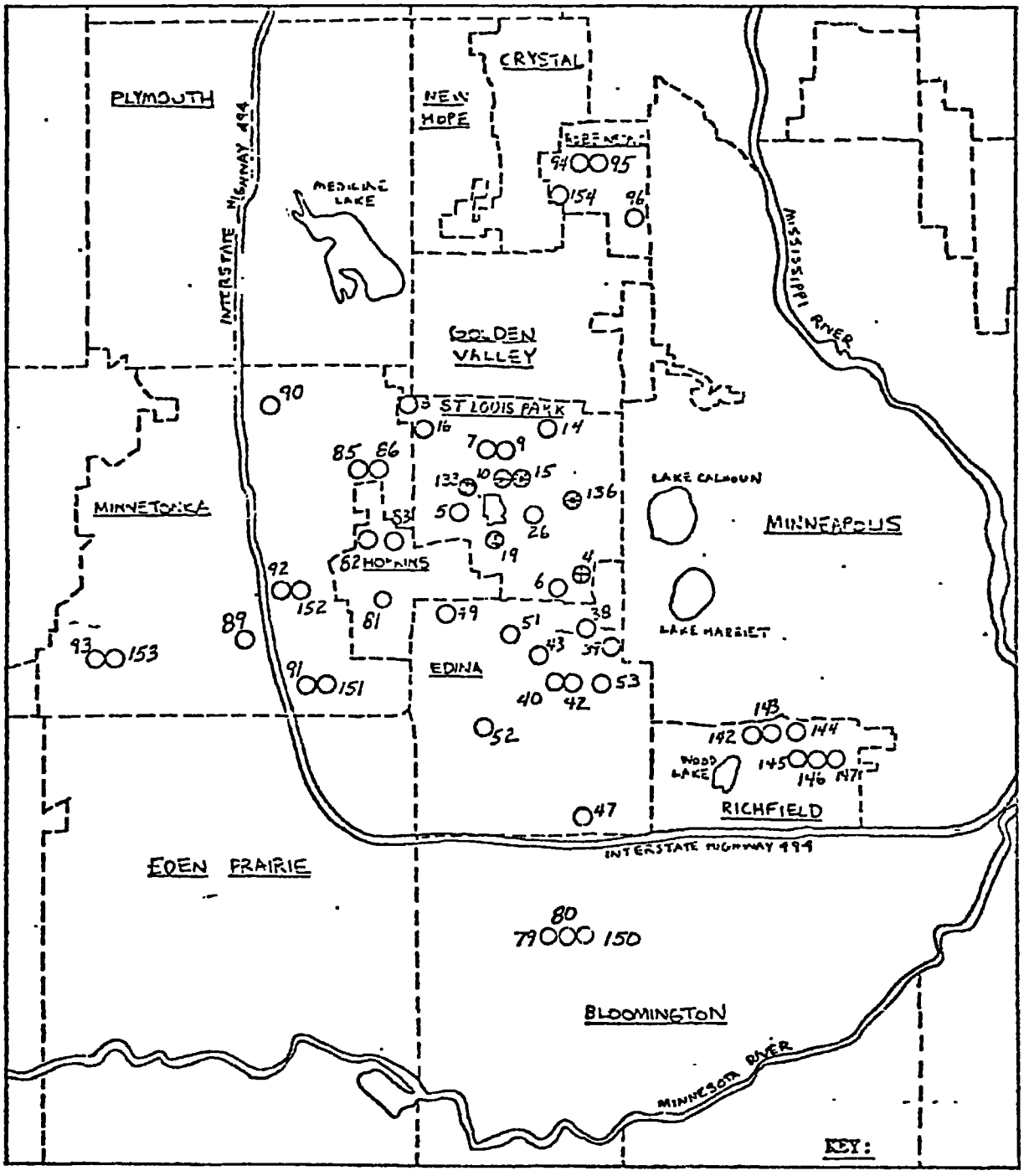
SCALE - 1" = 2.5 miles

KEY: Maximum possible PAH concentration measured:

- O < 300 ng/ℓ
- ⊕ 300 - 999 ng/ℓ
- ⊗ 1,000 - 10,000 ng/ℓ
- ◉ >10,000 ng/ℓ

007306

LOCATION OF WELLS IN THE PRAIRIE-DU-CHIEN-JORDAN AQUIFER ANALYZED FOR PAH

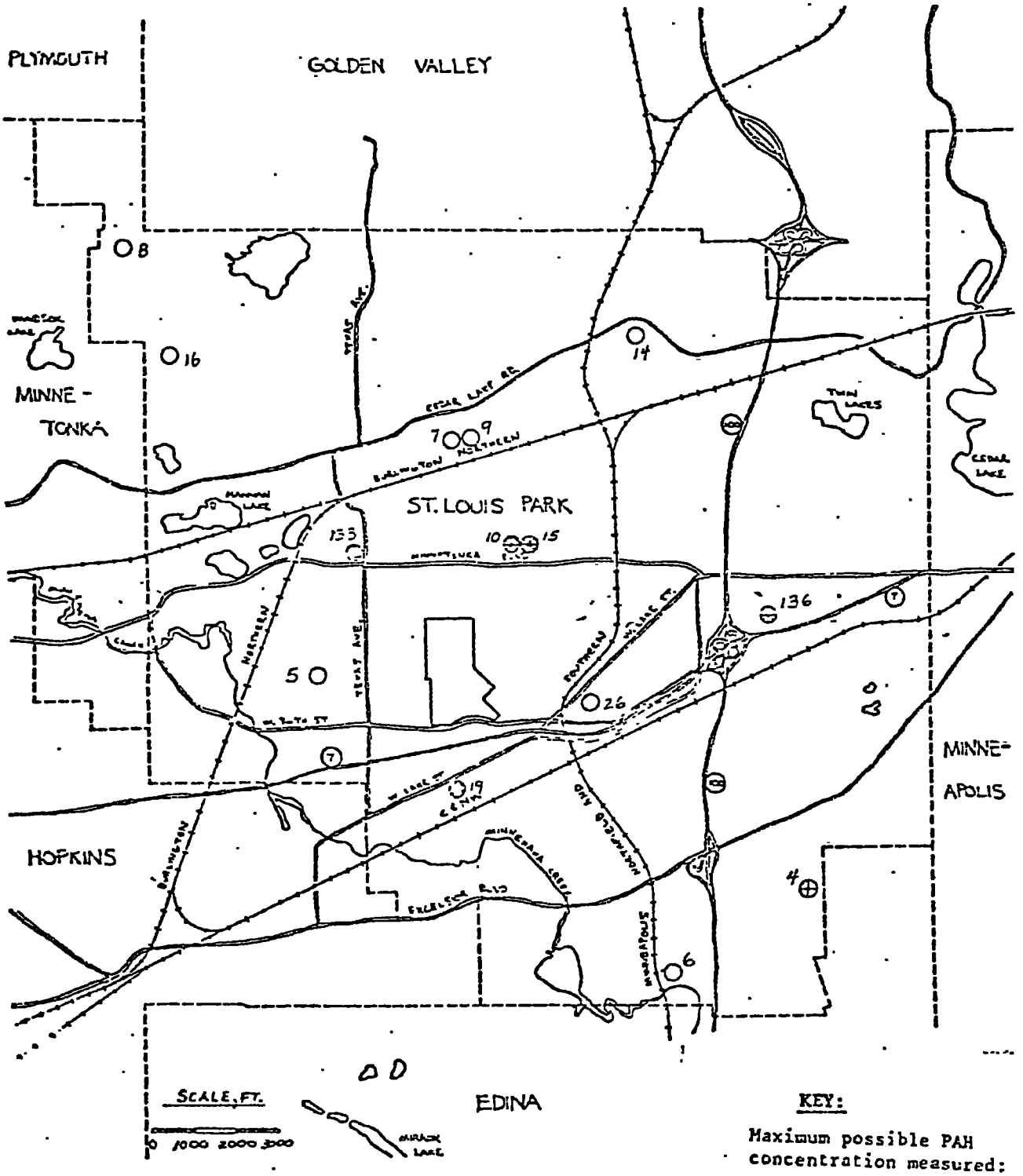


SCALE - 1" = 2.5 miles

KEY: Maximum possible PAH concentration measured:

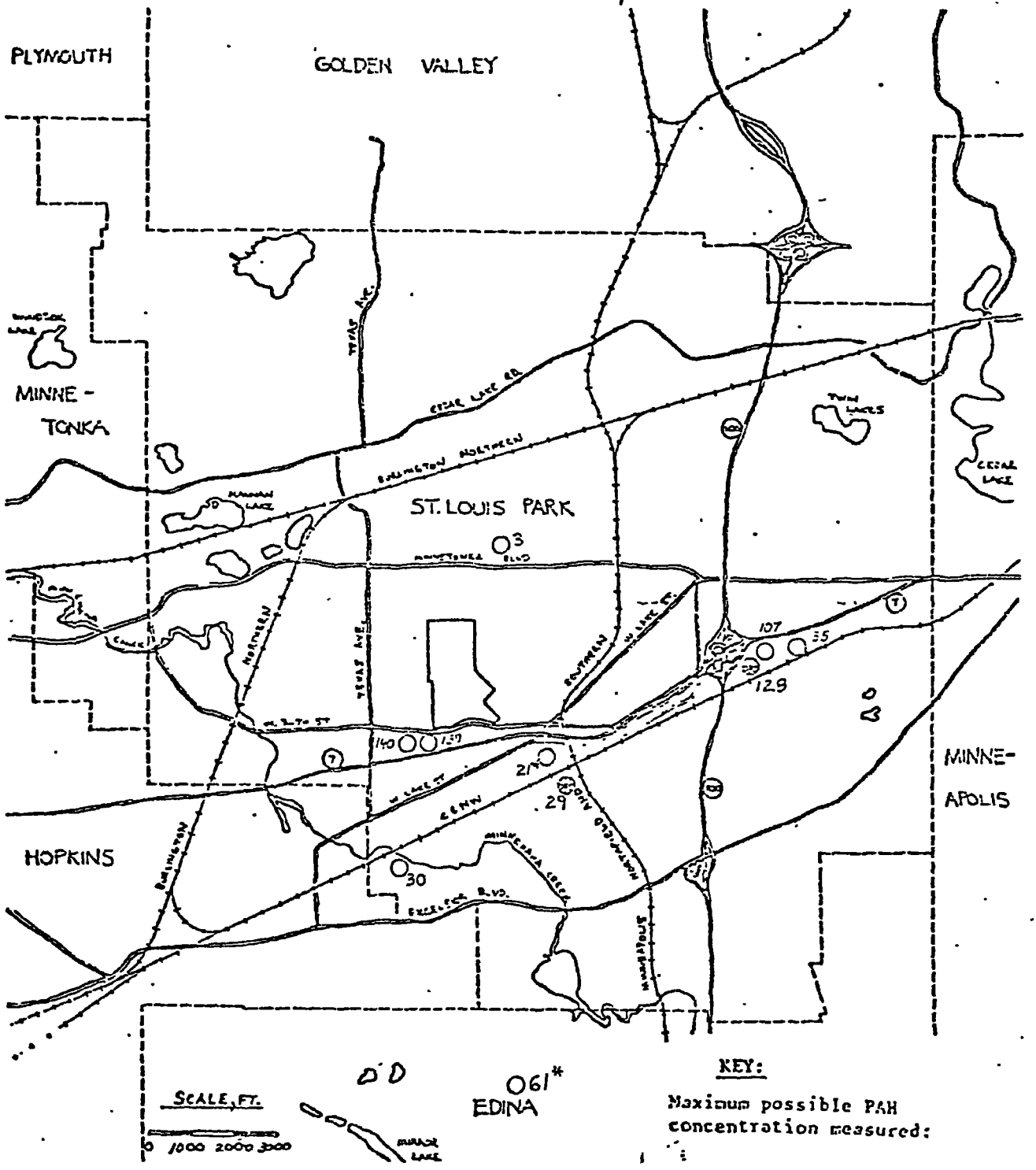
- ○ < 300 ng/ℓ
- ⊕ 300 - 999 ng/ℓ
- ⊗ 1,000 - 10,000 ng/ℓ
- ● >10,000 ng/ℓ

LOCATION OF WELLS IN ST. LOUIS PARK IN THE PRAIRIE-DU-CHIEN-JORDAN AQUIFER ANALYZED FOR PAH



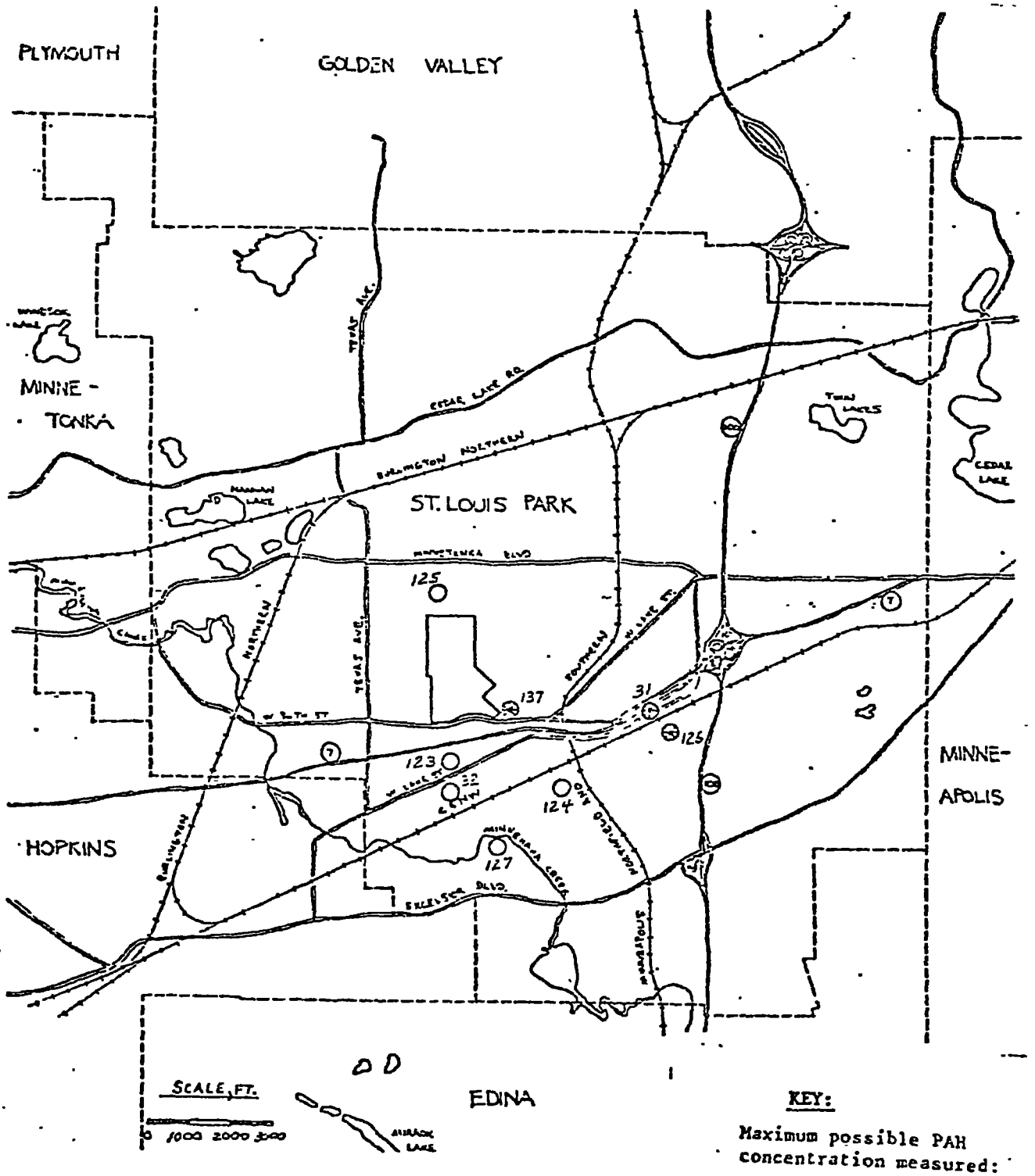
007308

LOCATION OF WELLS IN BOTH THE PLATTEVILLE AND ST. PETER AQUIFERS ANALYZED FOR PAH



007309

LOCATION OF WELLS IN THE PLATTEVILLE AQUIFER ANALYZED FOR PAH



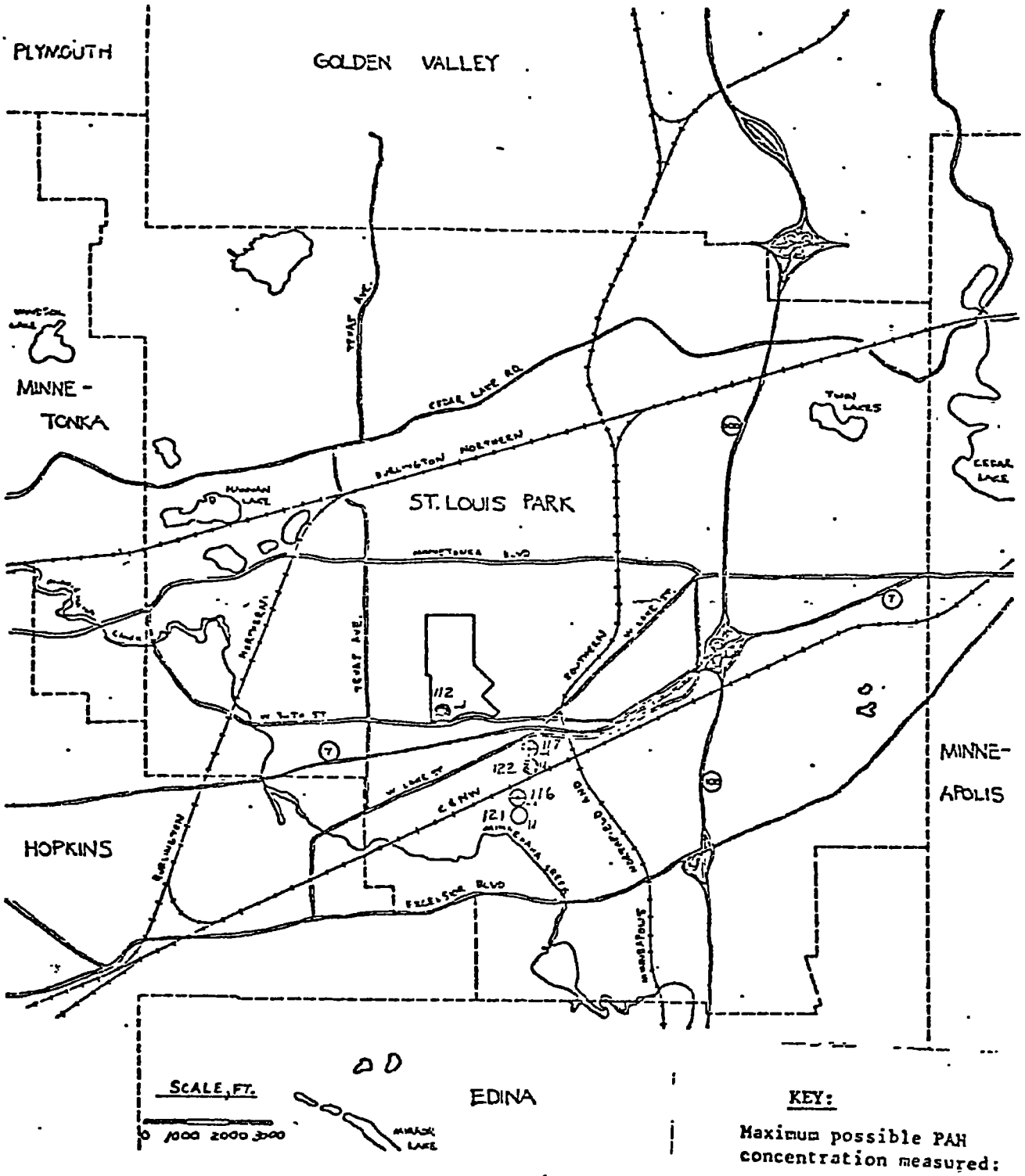
KEY:

Maximum possible PAH concentration measured:

- ○ < 300 ng/ℓ
- ⊕ 300 – 999 ng/ℓ
- ⊗ 1,000 – 10,000 ng/ℓ
- ◉ >10,000 ng/ℓ

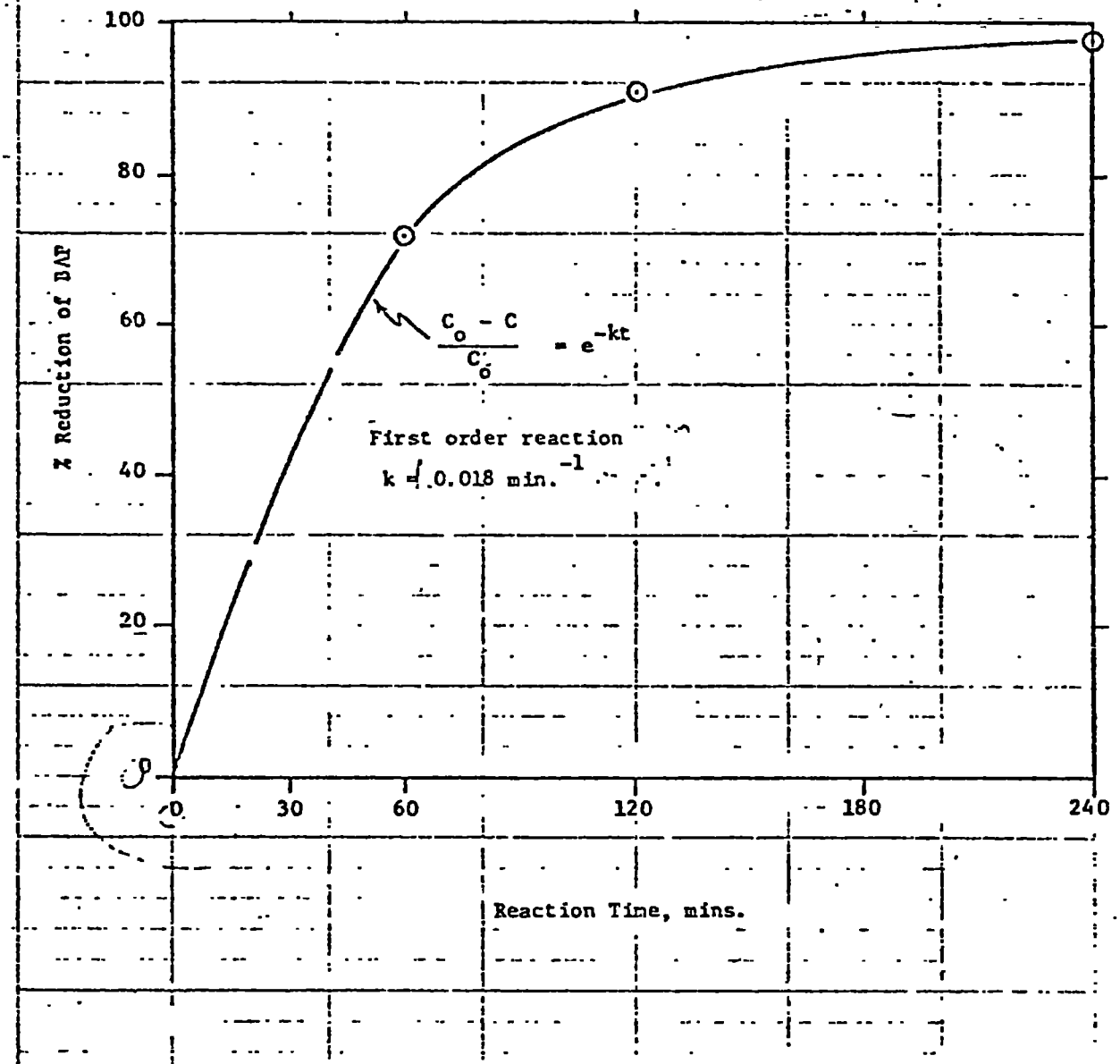
007310

LOCATION OF WELLS IN THE COMBINED GLACIAL DRIFT AQUIFER ANALYZED FOR PAH



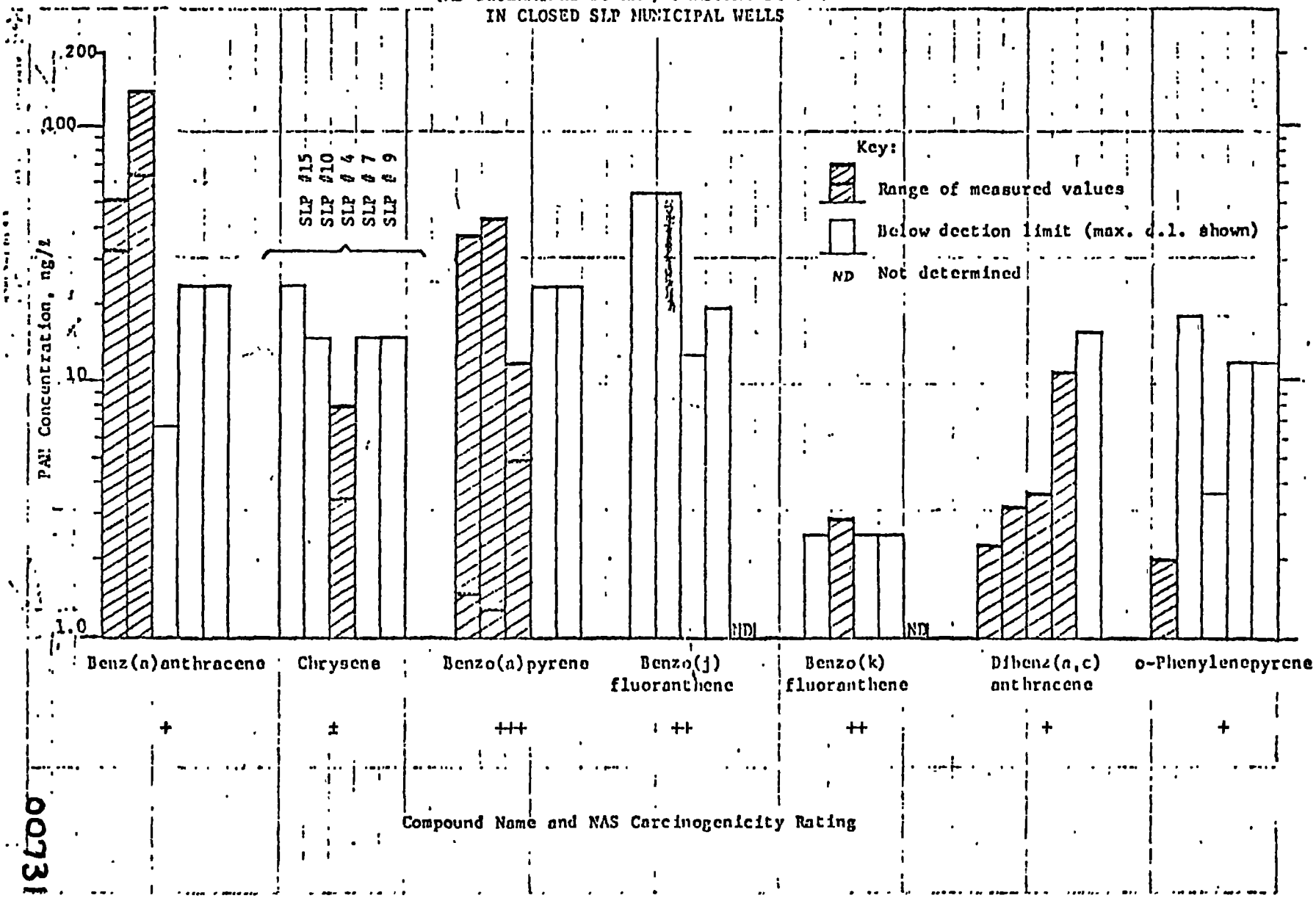
007311

HYDROGEN PEROXIDE TREATMENT OF BENZO(a)PYRENE IN DRINKING WATER (DATA OF BERGLIND ET AL*)



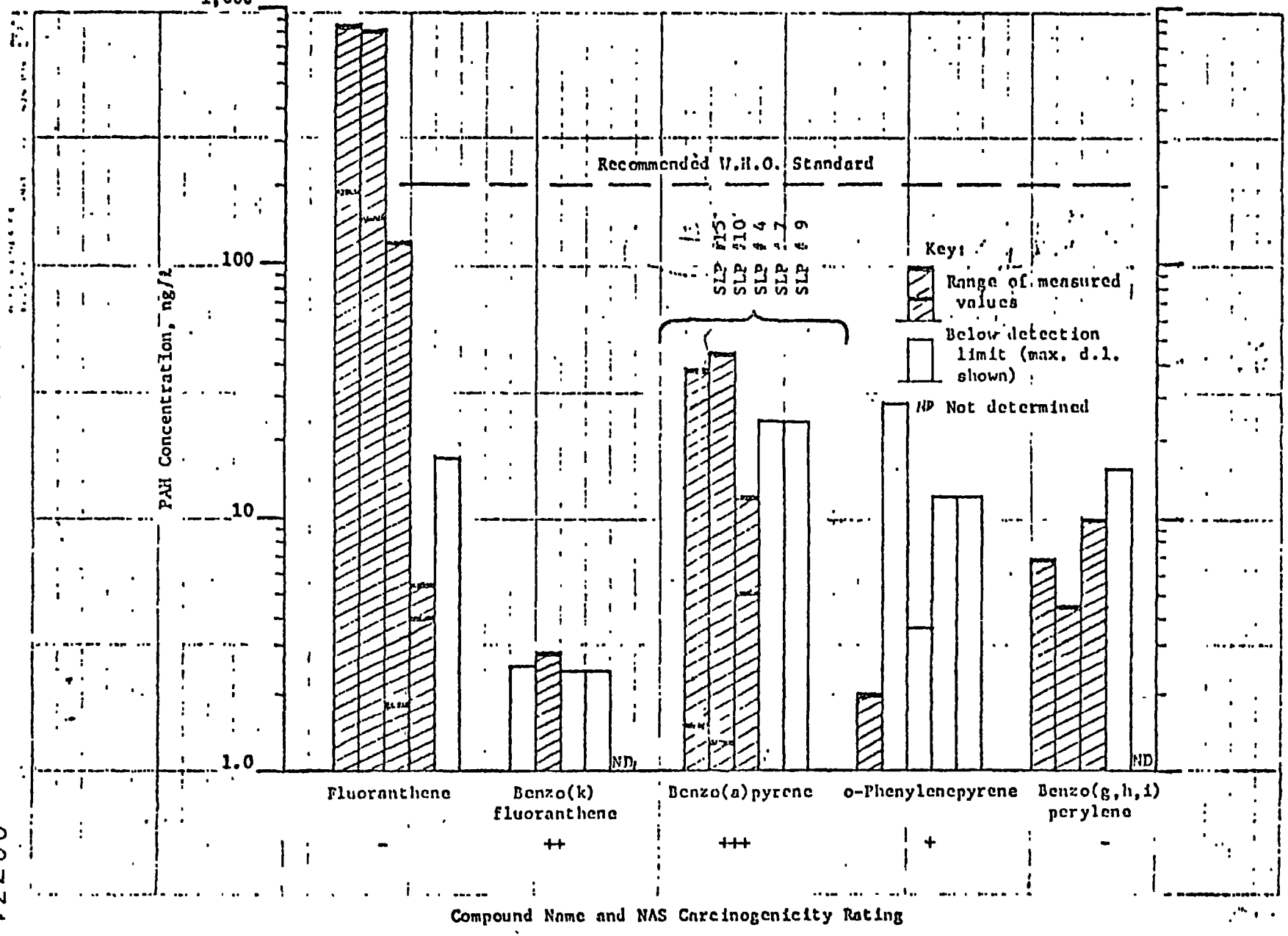
*Berglind, L., E. Gjessing and E. Skipperud Johanson (1979) Removal of Organic Matter From Water by UV and Hydrogen Peroxide. Proc of Conf. on Oxidation Techniques in Drinking Water Treatment, Karlsruhe, Federal Republic of Germany. EPA-570/9-79-020.

CONCENTRATIONS OF CARCINOGENIC PAHs
(AS DETERMINED BY NAS) MEASURED BY MDH
IN CLOSED SLP MUNICIPAL WELLS



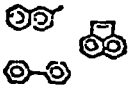
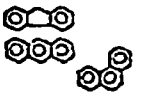
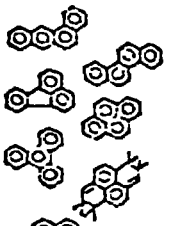
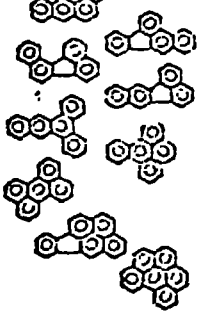
007313

CONCENTRATIONS OF W.H.O. LIST PAHs
IN CLOSED SLP MUNICIPAL WELLS



007314

PAH COMPOUNDS ANALYZED BY MDH
IN GROUNDWATER SAMPLES
AND THEIR RELATIVE NAS CARCINOGENICITY RATING

Compound Name	NAS Rating**	Structure
2-RING COMPOUNDS		
2-Methylanaphthalene	(not rated)	
Acenaphthene	"	
Biphenyl	"	
3-RING COMPOUNDS		
Fluorene	-	
Anthracene	-	
Phenanthrene	-	
4-RING COMPOUNDS		
Benz(a)anthracene	+	
Chrysene	±	
*Fluoranthene	-	
Pyrene	-	
Triphenylene (9,10-benzophenanthrene)	(not rated)	
1,2,6,7 -Tetrahydropyrene	"	
5-RING COMPOUNDS		
*Benzo(a)pyrene	+++	
*Benzo(b)fluoranthene	++	
Benzo(j)fluoranthene	++	
*Benzo(k)fluoranthene	++	
Dibenz (a,c)anthracene (1,2,3,4-dibenzanthracene)	+	
Benzo(e)pyrene	-	
Perylene	-	
6-RING COMPOUNDS		
*Indeno (1,2,3-cd)pyrene (o-phenylenepyrene)	+	
*Benzo(g,h,i)perylene	-	

* Indicates compound in W.H.O. list for recommended PAH drinking water standard.

** Ratings by the National Academy of Sciences Committee on Biological Effects of Atmospheric Pollutants ("Particulate Polycycle Organic Matter", 1972) indicate:

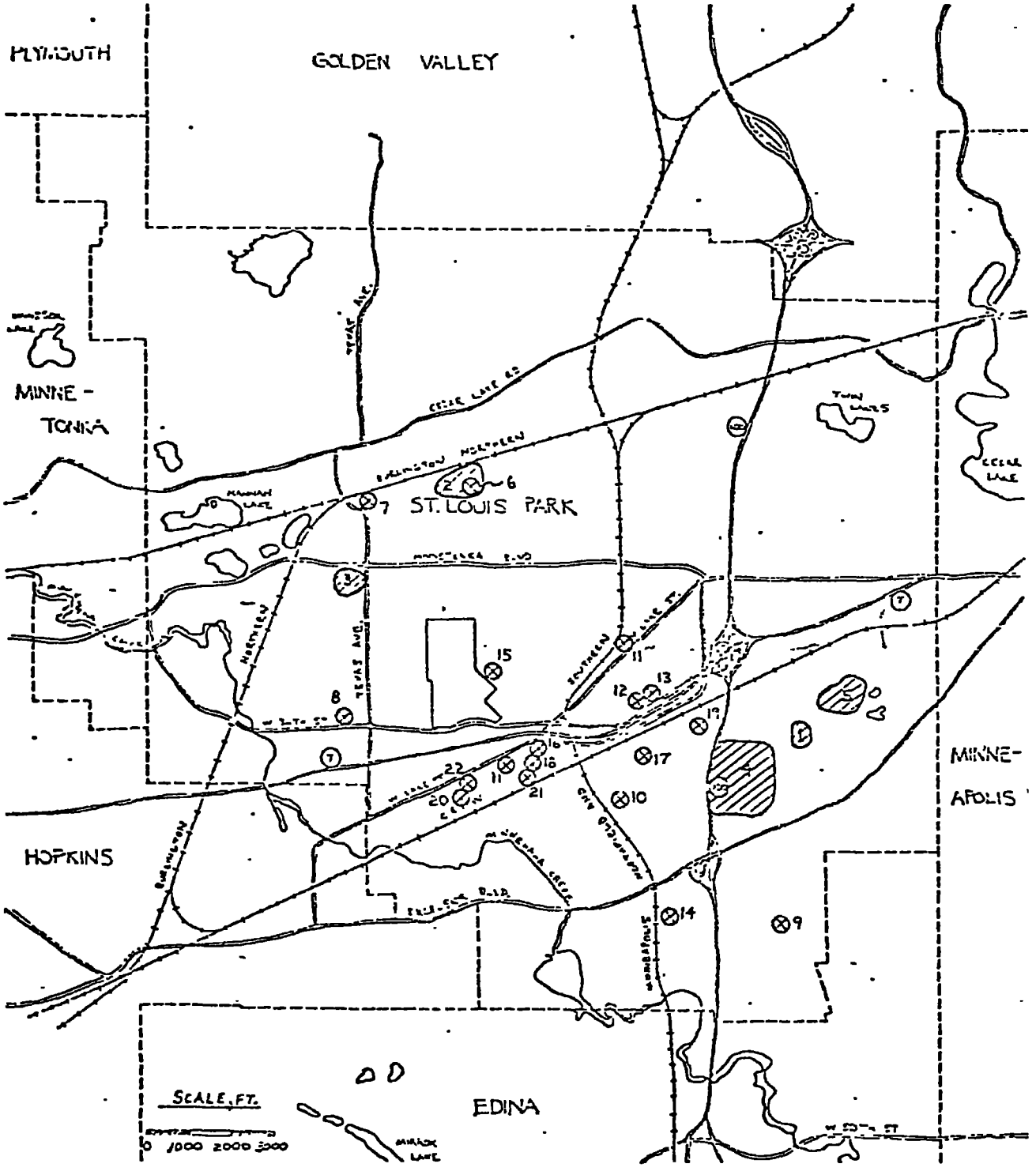
- \- not carcinogenic
- ± uncertain or weakly carcinogenic
- \+ carcinogenic
- ++ ,+++ ,++++ strongly carcinogenic

POTENTIAL PAH GROUND AND WATER
EMISSION SOURCES IN ST. LOUIS PARK

Map Number	Description	Approximate Dates
Dumps and Landfills		
1	City dump	1938-43
2	City dump (old gravel pit area)	1943-50
3	City dump and landfill	1950-54
4	Open burning dump and landfill (old gravel pit area)	1951-62
5	Fill area for municipal incinerator ash	1959-68
Paving and Roofing Mixtures Dealers		
6	J. V. Gleason Company	1946-~1960
7	J. V. Gleason Company	early 1960's
8	J. V. Gleason Company	late 1960's
9	Glenn Johnson Contracting	1950's
10	Black Top Service Company	1960's
Coal and Fuel Dealers		
11	Minneapolis Coal Company	unknown
12	Leslie Fuel & Oil	1940's
13	J. K. Seirup Fuel & Oil	unknown
14	Young Fuel Company	1940's
Rubber Products Manufacturers		
15	Finney Company, Inc.	1960-80
16	Robinson Rubber Products	1955-80
17	Minnesota Rubber	1955-80
Miscellaneous Industry Sources		
18	Golden Auto Parts	~1965-80
19	D&A Lubricants	<1980
20	Flame Industries	<1980
21	Prestolite	1920's
22	Androc Chemical Company	1946-75
Non-Site Specific Sources		
NA	City road tarring operations	1930's & 1940's
NA	Septic tank systems	up to early 1960's
NA	Railroad Lines	1900-1980

petroleum grease for well seals

007316



LOCATION OF POTENTIAL ANTHROPOGENIC PAH SOURCES
IN ST. LOUIS PARK

RANGE OF PAH LEVELS IN FOODSTUFFS,* (ppb)

Foodstuff	Benzo(a)pyrene	Total PAH
Vegetable Oils	0.2-6.8	2.1-136
Fish		
Smoked	Tr-6.6	5.2-162
Non-Smoked	ND	1.8-3.2
Smoked Meat	Tr-3.6	1.5-150
Cooked Meat		
Charcoal Broiled		
Hamburger	0-2.6	0.3-44
Steak	4.4-50.4	70-184
Barbecued	3.5-10.5	38-186
Fruits	ND-30	
Grain and Cereal	0.1-60	
Sugars	0.2-72	
Vegetables	ND-24	
Beverages	ND-21	
Untreated SLP Well #15 Water	0.002-0.04	2.1-5.6

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* Santodonato, J., D. Basu, and P. H. Howard, "Multimedia Human Exposure and Carcinogenic Risk Assessment for Environmental PAH," in Polynuclear Aromatic Hydrocarbons: Chemistry and Biological Effects, A. Bjorseth and A. J. Dennis eds., Battelle Press, 1980.

WORST CASE
COMPARISON OF PAH EXPOSURES
FROM DRINKING UNTREATED SLP WELL #15 WATER
AND FROM FOOD AND INHALATION SOURCES

COMPOUND	NAS RATING[a]	INGESTION, μg/day, via: FOOD	2 liters/day UNTREATED SLP #15 WATER[b]	INHALATION, μg/day, via: ONE PACK CIGARETTES	AMBIENT AIR
Anthracene	-	0.1[c]	0.1-1.1	-	-
Fluoronthene	-	3.8[c]	0.4-1.7	-	-
Pyrene	-	3.4[c]	0.1-2.4	-	-
Benzo(a)pyrene	+++	0.16-1.6[d]	0.003-0.08	0.4	0.02
Total PAH	NA	1.6-16[d]	2.6-16	-	-

a- Ratings by the National Academy of Sciences Committee on Biological Effects of Atmospheric Pollutants ("Particulate Polycycle Organic Matter", 1972). indicate:

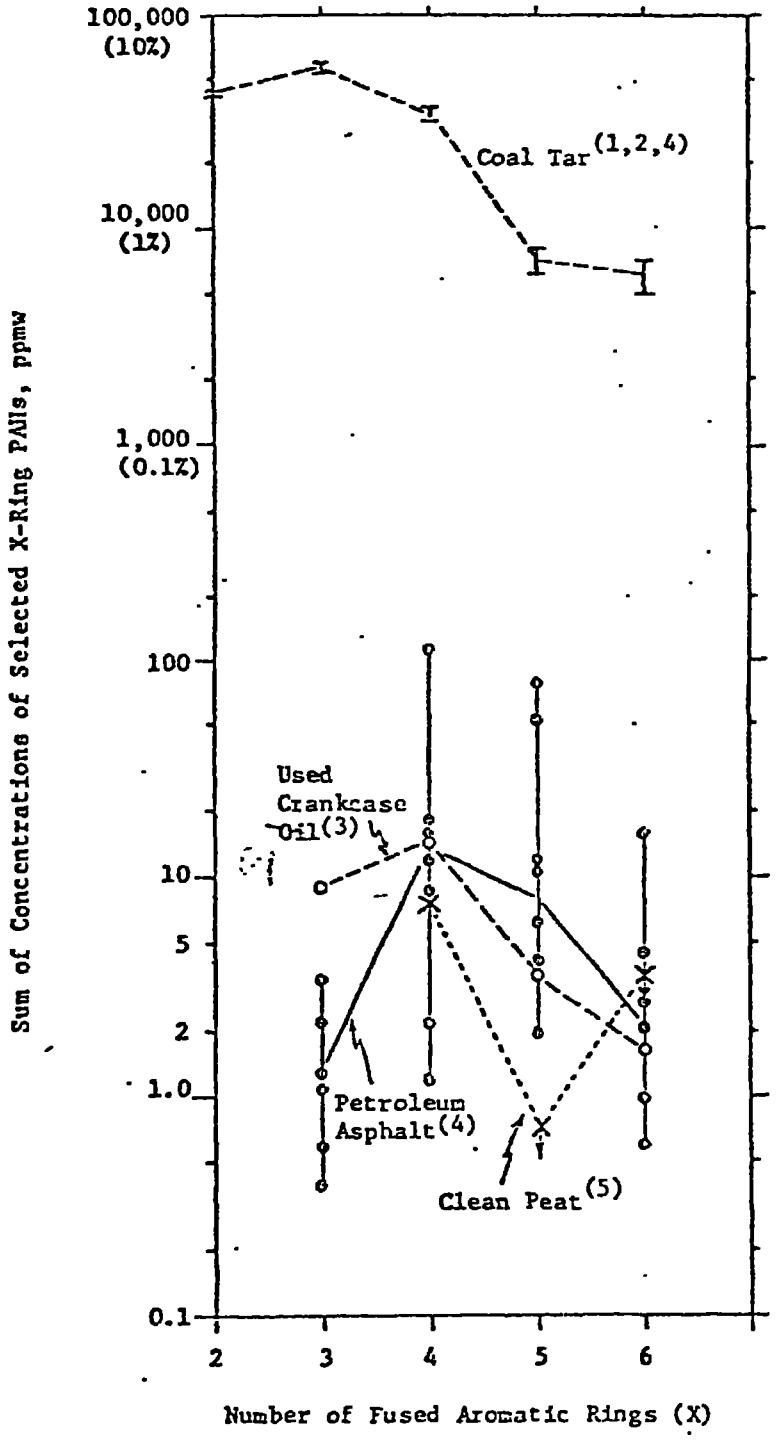
- \- not carcinogenic
- ± uncertain or weakly carcinogenic
- \+ carcinogenic
- ++, +++, ++++ strongly carcinogenic

b Based on MDH analyses from 7/79 to 1/80 and consumption of 2 liters/day.

c From MDH report "Health Implication of PAH in St. Louis Park Drinking Water," November 1978.

d From Bridboard, K et al., "Human Exposure to PAHs", in Carcinogenesis, A Comprehensive Survey, Vol. I, R. Freudenthal and P. Jones, eds., Raven Press, 1976.

RELATIVE AMOUNTS OF SELECTED PAHs
IN COAL TAR AND OTHER INDUSTRIAL MATERIALS



EXPLANATION:

Points plotted represent the summation of measured concentrations of the 21 specific PAHs analyzed in groundwater samples by the MDH that are present in coal tar, asphalt, and used crankcase oil. Exceptions are 1,2,6,7-tetrahydropyrene and benzo(b)fluoranthene, which were not determined in these materials, and dibenz(a,c,) anthracene, benzo(j)fluoranthene, and indeno(1,2,3-cd)pyrene, which were only determined in some instances. Coal tar concentrations sometimes based on results for creosote (ref. 2) or pitch (ref. 4) assuming that coal tar contains 30% creosote and 60% pitch.

(1) Lijinsky, W., et al, Anal. Chem. 35: 952-956, 1963.

(2) Lorenz, L. F. and L. R. Gjovik, Proc. AWPA 68: 32-42, 1972.

(3) Peake, E. and K. Parker, "PAHs and the Mutagenicity of Used Crank Oils" in Polynuclear Aromatic Hydrocarbons: Chemistry and Biological Effects, A. Bjorseth and A. J. Dennis, eds, Battelle Press, 1980, p. 1025ff.

(4) Wallcave, L. H., et al, Toxicology & Applied Pharmacology 18: 41-52, 1971.

(5) National Biocentric Inc. "Soil Boring and Chemical Analysis of the Northern Portion of Oak Park Village", 9/17/76.

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