Client: ATEC Environmental Services
Client Address: 2551 Eltham Avenue, Suite Z
Norfolk, VA 23513

Client Project Number: 26-08108
Client Sample Identification: SS-4
Sample Matrix: Soil
Date Sample Collected: June 25, 1990
Date Sample Received: June 26, 1990
Date Sample Extracted: June 27, 1990
Dated Sample Analyzed: July 5, 1990
Analytical Equipment: Incos BS

SEMI-VOLATILE COMPOUNDS
ANALYTICAL RESULTS

ATEC Lab No. 9006241-20

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Phenol	108-95-2	< 330	330
bis(2-Chloroethyl) Ether	111-44-4	< 330	330
2-Chlorophenol	95-57-8	< 330	330
1,3-Dichlorobenzene	541-73-1	< 330	330
1,4-Dichlorobenzene	106-46-7	< 330	330
Benzyl Alcohol	100-51-6	< 330	330
1,2-Dichlorobenzene	95-50-1	< 330	330
2-Methylphenol	95-48-7	< 330	330
bis(2-Chloroisopropyl Ether	39638-32-9	< 330	330
4-Methylphenol	106-44-5	< 330	330
N-Nitroso-Di-n-propylamine	621-64-7	< 330	330
Hexachloroethane	67-72-1	< 330	330
Nitrobenzene	98-95-3	< 330	330
Isophorone	78-59-1	< 330	330
2-Nitrophenol	88-75-5	< 330	330

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. 9006241-20

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
2,4-Dimethylphenol	105-67-9	< 330	330
Benzoic Acid	65-85-0	<1,600	1,600
bis(2-chloroethoxy) Methane	111-91-1	< 330	330
2,4-Dichlorophenol	120-83-2	< 330	330
1,2,4-Trichlorobenzene	120-82-1	< 330	330
Naphthalene	91-20-3	< 330	330
4-Chloroaniline	106-47-8	< 330	330
Hexachlorobutadiene	87-68-3	< 330	330
4-Chloro-3-methylphenol	59-50-7	< 330	330
2-Methylnaphthalene	91-57-6	< 330	330
Hexachlorocylopentadiene	77-47-4	< 330	330
2,4,6-Trichlorophenol	88-06-2	< 330	330
2,4,5-Trichlorophenol	95-95-4	<1,600	1,600
2-Chloronaphthalene	91-58-7	< 330	330
2-Nitroaniline	88-74-4	<1,600	1,600
Dimethyl Phthalate	131-11-3	< 330	330
Acenaphthylene	208-96-8	< 330	330
3-Nitroaniline	99-09-2	<1,600	1,600
Acenaphthene	83-32-9	< 330	330
2,4-Dinitrophenol	51-28-5	<1,600	1,600
4-Nitrophenol	100-02-7	<1,600	1,600
Dibenzofuran	132-64-9	< 330	330
2,4-Dinitrotoluene	121-14-2	< 330	330
2,6-Dinitrotoluene	606-20-2	< 330	330
Diethylphthalate	84-66-2	< 330	330
4-Chlorophenyl-phenylether	7005-72-3	< 330	330
Fluorene	86-73-7	< 330	330
4-Nitroaniline	100-01-6	<1,600	1,600
4,6-Dinitro-2-methylphenol	534-52-1	<1,600	1,600

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. 9006241-20

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
N-Nitrosodiphenylamine	86-30-6	< 330	330
4-Bromophenyl-phenylether	101-55-3	< 330	330
Hexachlorobenzene	118-74-1	< 330	330
Pentachlorophenol	87-86-5	<1,600	1,600
Phenanthrene	85-01-8	< 330	330
Anthracene	120-12-7	< 330	330
Di-n-Butylphthalate	84-74-2	< 330	330
Fluoranthene	206-44-0	< 330	330
Pyrene	129-00-0	< 330	330
Butylbenzylphthalate	85-68-7	< 330	330
3,3'-Dichlorobenzidine	91-94-1	< 660	660
Benzo(a)anthracene	56-55-3	< 330	330
bis(2-Ethylhexyl)phthalate	117-81-7	< 330	330
Chrysene	218-01-9	< 330	330
Di-n-Octyl Phthalate	117-84-0	< 330	330
Benzo(b)fluoranthene	205-99-2	< 330	330
Benzo(k)fluoranthene	207-08-9	< 330	330
Benzo(a)pyrene	50-32-8	< 330	330
Indeno(1,2,3-cd)pyrene	193-39-5	< 330	330
Dibenz(a,h)anthracene	53-70-3	< 330	330
Benzo(g,h,i)perylene	191-24-2	< 330	330

* Analyte detected but amount present is less than the Quantitation Limit.

Analytical Method: SW 846 Method 8270

Analyst: J. Rigdon
Verified: M. McGill
Date Reported: July 9, 1990

Respectfully submitted,

Keith S. Kline

Environmental/Analytical Testing Division

Client: ATEC Environmental Services
Client Address: 2551 Eltham Avenue, Suite Z
Norfolk, VA 23513

Client Project Number: 26-08108
Client Sample Identification: SS-5
Sample Matrix: Soil
Date Sample Collected: June 25, 1990
Date Sample Received: June 26, 1990
Date Sample Analyzed: July 2, 1990
Analytical Equipment: 1020A

VOLATILE COMPOUNDS
ANALYTICAL RESULTS

ATEC Lab No. 9006241-21

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Chloromethane	74-87-3	<10	10
Bromomethane	74-83-9	<10	10
Vinyl Chloride	75-01-4	<10	10
Chloroethane	75-00-3	<10	10
Methylene Chloride	75-09-2	11	5
Acetone	67-64-1	<10*	10
Carbon Disulfide	75-15-0	< 5	5
1,1-Dichloroethene	75-35-4	< 5	5
1,1-Dichloroethane	75-35-3	< 5	5
Trans-1,2-Dichloroethene	156-60-5	< 5	5
Chloroform	67-66-3	< 5	5
1,2-Dichloroethane	107-06-2	< 5	5
2-Butanone	78-93-3	<10	10
1,1,1-Trichloroethane	71-55-6	< 5	5
Carbon Tetrachloride	56-23-5	< 5	5
Vinyl Acetate	108-05-4	<10	10
Bromodichloromethane	75-27-4	< 5	5
1,2-Dichloropropane	78-87-5	< 5	5

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. 9006241-21

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Trans-1, 3-Dichloropropene	10061-02-6	< 5	5
Trichloroethene	79-01-6	< 5	5
Dibromochloromethane	124-48-1	< 5	5
1,1,2-Trichloroethane	79-00-5	< 5	5
Benzene	71-43-2	< 5*	5
cis-1,3-Dichloropropene	10061-01-5	< 5	5
2-Chloroethylvinylether	110-75-8	<10	10
Bromoform	75-25-2	< 5	5
4-Methyl-2-Pentanone	108-10-1	<10	10
2-Hexanone	591-78-6	<10	10
Tetrachloroethene	127-18-4	< 5	5
1,1,2,2-Tetrachloroethane	79-34-5	< 5	5
Toluene	108-88-3	< 5	5
Chlorobenzene	108-90-7	< 5	5
Ethylbenzene	100-41-4	< 5	5
Styrene	100-42-5	< 5	5
Total Xylenes		< 5	5

* Analyte detected but amount present is less than the Quantitation Limit.

Analytical Method: SW 846 Method 8240

Analyst: T. Harrison
Verified: M. McGill
Date Reported: July 2, 1990

Respectfully submitted,

Keith S. Kline

Environmental/Analytical Testing Division

Client: ATEC Environmental Services
Client Address: 2551 Eltham Avenue, Suite Z
Norfolk, VA 23513

Client Project Number: 26-08108
Client Sample Identification: SS-6
Sample Matrix: Soil
Date Sample Collected: June 25, 1990
Date Sample Received: June 26, 1990
Date Sample Extracted: June 27, 1990
Dated Sample Analyzed: July 5, 1990
Analytical Equipment: Incos BS

SEMI-VOLATILE COMPOUNDS
ANALYTICAL RESULTS

ATEC Lab No. 9006241-22

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Phenol	108-95-2	< 330	330
bis(2-Chloroethyl) Ether	111-44-4	380	330
2-Chlorophenol	95-57-8	< 330	330
1,3-Dichlorobenzene	541-73-1	< 330	330
1,4-Dichlorobenzene	106-46-7	< 330	330
Benzyl Alcohol	100-51-6	< 330	330
1,2-Dichlorobenzene	95-50-1	< 330	330
2-Methylphenol	95-48-7	< 330	330
bis(2-Chloroisopropyl Ether	39638-32-9	< 330	330
4-Methylphenol	106-44-5	< 330	330
N-Nitroso-Di-n-propylamine	621-64-7	< 330	330
Hexachloroethane	67-72-1	< 330	330
Nitrobenzene	98-95-3	< 330	330
Isophorone	78-59-1	< 330	330
2-Nitrophenol	88-75-5	< 330	330

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. 9006241-22

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
2,4-Dimethylphenol	105-67-9	< 330	330
Benzoic Acid	65-85-0	<1,600	1,600
bis(2-chloroethoxy) Methane	111-91-1	< 330	330
2,4-Dichlorophenol	120-83-2	< 330	330
1,2,4-Trichlorobenzene	120-82-1	< 330	330
Naphthalene	91-20-3	< 330	330
4-Chloroaniline	106-47-8	< 330	330
Hexachlorobutadiene	87-68-3	< 330	330
4-Chloro-3-methylphenol	59-50-7	< 330	330
2-Methylnaphthalene	91-57-6	< 330	330
Hexachlorocylopentadiene	77-47-4	< 330	330
2,4,6-Trichlorophenol	88-06-2	< 330	330
2,4,5-Trichlorophenol	95-95-4	<1,600	1,600
2-Chloronaphthalene	91-58-7	< 330	330
2-Nitroaniline	88-74-4	<1,600	1,600
Dimethyl Phthalate	131-11-3	< 330	330
Acenaphthylene	208-96-8	< 330	330
3-Nitroaniline	99-09-2	<1,600	1,600
Acenaphthene	83-32-9	< 330	330
2,4-Dinitrophenol	51-28-5	<1,600	1,600
4-Nitrophenol	100-02-7	<1,600	1,600
Dibenzofuran	132-64-9	< 330	330
2,4-Dinitrotoluene	121-14-2	< 330	330
2,6-Dinitrotoluene	606-20-2	< 330	330
Diethylphthalate	84-66-2	< 330	330
4-Chlorophenyl-phenylether	7005-72-3	< 330	330
Fluorene	86-73-7	< 330	330
4-Nitroaniline	100-01-6	<1,600	1,600
4,6-Dinitro-2-methylphenol	534-52-1	<1,600	1,600

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. 9006241-22

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
N-Nitrosodiphenylamine	86-30-6	< 330	330
4-Bromophenyl-phenylether	101-55-3	< 330	330
Hexachlorobenzene	118-74-1	< 330	330
Pentachlorophenol	87-86-5	<1,600	1,600
Phenanthrene	85-01-8	< 330	330
Anthracene	120-12-7	< 330	330
Di-n-Butylphthalate	84-74-2	< 330	330
Fluoranthene	206-44-0	< 330	330
Pyrene	129-00-0	< 330	330
Butylbenzylphthalate	85-68-7	< 330	330
3,3'-Dichlorobenzidine	91-94-1	< 660	660
Benzo(a)anthracene	56-55-3	< 330	330
bis(2-Ethylhexyl)phthalate	117-81-7	< 330	330
Chrysene	218-01-9	< 330	330
Di-n-Octyl Phthalate	117-84-0	< 330	330
Benzo(b)fluoranthene	205-99-2	< 330	330
Benzo(k)fluoranthene	207-08-9	< 330	330
Benzo(a)pyrene	50-32-8	< 330	330
Indeno(1,2,3-cd)pyrene	193-39-5	< 330	330
Dibenz(a,h)anthracene	53-70-3	< 330	330
Benzo(g,h,i)perylene	191-24-2	< 330	330

* Analyte detected but amount present is less than the Quantitation Limit.

Analytical Method: SW 846 Method 8270

Analyst: J. Rigdon
Verified: M. McGill
Date Reported: July 9, 1990

Respectfully submitted,

Keith S. Kline

Environmental/Analytical Testing Division

Client: ATEC Environmental Services
Client Address: 2551 Eltham Avenue, Suite Z
Norfolk, VA 23513

Client Project Number: 26-08108
Client Sample Identification: Method Blank
Sample Matrix: Soil
Date Sample Analyzed: June 29, 1990
Analytical Equipment: 1020A

VOLATILE COMPOUNDS
ANALYTICAL RESULTS

ATEC Lab No. BLANK062990

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Chloromethane	74-87-3	<10	10
Bromomethane	74-83-9	<10	10
Vinyl Chloride	75-01-4	<10	10
Chloroethane	75-00-3	<10	10
Methylene Chloride	75-09-2	11	5
Acetone	67-64-1	<10	10
Carbon Disulfide	75-15-0	< 5	5
1,1-Dichloroethene	75-35-4	< 5	5
1,1-Dichloroethane	75-35-3	< 5	5
Trans-1,2-Dichloroethene	156-60-5	< 5	5
Chloroform	67-66-3	< 5	5
1,2-Dichloroethane	107-06-2	< 5	5
2-Butanone	78-93-3	<10	10
1,1,1-Trichloroethane	71-55-6	< 5	5
Carbon Tetrachloride	56-23-5	< 5	5
Vinyl Acetate	108-05-4	<10	10
Bromodichloromethane	75-27-4	< 5	5
1,2-Dichloropropane	78-87-5	< 5	5

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. BLANK062990

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Trans-1, 3-Dichloropropene	10061-02-6	< 5	5
Trichloroethene	79-01-6	< 5	5
Dibromochloromethane	124-48-1	< 5	5
1,1,2-Trichloroethane	79-00-5	< 5	5
Benzene	71-43-2	< 5*	5
cis-1,3-Dichloropropene	10061-01-5	< 5	5
2-Chloroethylvinylether	110-75-8	<10	10
Bromoform	75-25-2	< 5	5
4-Methyl-2-Pentanone	108-10-1	<10	10
2-Hexanone	591-78-6	<10	10
Tetrachloroethene	127-18-4	< 5	5
1,1,2,2-Tetrachloroethane	79-34-5	< 5	5
Toluene	108-88-3	< 5	5
Chlorobenzene	108-90-7	< 5	5
Ethylbenzene	100-41-4	< 5	5
Styrene	100-42-5	< 5	5
Total Xylenes		< 5	5

* Analyte detected but amount present is less than the Quantitation Limit.

Analytical Method: SW 846 Method 8240

Analyst: T. Harrison
Verified: M. McGill
Date Reported: July 2, 1990

Respectfully submitted,

Keith S. Kline

Environmental/Analytical Testing Division

Client: ATEC Environmental Services
Client Address: 2551 Eltham Avenue, Suite Z
Norfolk, VA 23513

Client Project Number: 26-08108
Client Sample Identification: Method Blank
Sample Matrix: Soil
Date Sample Analyzed: July 2, 1990
Analytical Equipment: 1020A

VOLATILE COMPOUNDS
ANALYTICAL RESULTS

ATEC Lab No. BLANK070290

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Chloromethane	74-87-3	<10	10
Bromomethane	74-83-9	<10	10
Vinyl Chloride	75-01-4	<10	10
Chloroethane	75-00-3	<10	10
Methylene Chloride	75-09-2	14	5
Acetone	67-64-1	<10	10
Carbon Disulfide	75-15-0	< 5	5
1,1-Dichloroethene	75-35-4	< 5	5
1,1-Dichloroethane	75-35-3	< 5	5
Trans-1,2-Dichloroethene	156-60-5	< 5	5
Chloroform	67-66-3	< 5	5
1,2-Dichloroethane	107-06-2	< 5	5
2-Butanone	78-93-3	<10	10
1,1,1-Trichloroethane	71-55-6	< 5	5
Carbon Tetrachloride	56-23-5	< 5	5
Vinyl Acetate	108-05-4	<10	10
Bromodichloromethane	75-27-4	< 5	5
1,2-Dichloropropane	78-87-5	< 5	5

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. BLANK070290

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Trans-1, 3-Dichloropropene	10061-02-6	< 5	5
Trichloroethene	79-01-6	< 5	5
Dibromochloromethane	124-48-1	< 5	5
1,1,2-Trichloroethane	79-00-5	< 5	5
Benzene	71-43-2	< 5	5
cis-1,3-Dichloropropene	10061-01-5	< 5	5
2-Chloroethylvinylether	110-75-8	<10	10
Bromoform	75-25-2	< 5	5
4-Methyl-2-Pentanone	108-10-1	<10	10
2-Hexanone	591-78-6	<10	10
Tetrachloroethene	127-18-4	< 5	5
1,1,2,2-Tetrachloroethane	79-34-5	< 5	5
Toluene	108-88-3	< 5	5
Chlorobenzene	108-90-7	< 5	5
Ethylbenzene	100-41-4	< 5	5
Styrene	100-42-5	< 5	5
Total Xylenes		< 5	5

* Analyte detected but amount present is less than the Quantitation Limit.

Analytical Method: SW 846 Method 8240

Analyst: T. Harrison
Verified: M. McGill
Date Reported: July 2, 1990

Respectfully submitted,

Keith S. Kline

Environmental/Analytical Testing Division

Client: ATEC Environmental Services
Client Address: 2551 Eltham Avenue, Suite Z
Norfolk, VA 23513

Client Project Number: 26-08108
Client Sample Identification: Method Blank
Sample Matrix: Soil
Date Sample Extracted: June 27, 1990
Dated Sample Analyzed: July 2, 1990
Analytical Equipment: Incos BS

SEMI-VOLATILE COMPOUNDS
ANALYTICAL RESULTS

ATEC Lab No. BLANK070290

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Phenol	108-95-2	< 330	330
bis(2-Chloroethyl) Ether	111-44-4	< 330	330
2-Chlorophenol	95-57-8	< 330	330
1,3-Dichlorobenzene	541-73-1	< 330	330
1,4-Dichlorobenzene	106-46-7	< 330	330
Benzyl Alcohol	100-51-6	< 330	330
1,2-Dichlorobenzene	95-50-1	< 330	330
2-Methylphenol	95-48-7	< 330	330
bis(2-Chloroisopropyl Ether	39638-32-9	< 330	330
4-Methylphenol	106-44-5	< 330	330
N-Nitroso-Di-n-propylamine	621-64-7	< 330	330
Hexachloroethane	67-72-1	< 330	330
Nitrobenzene	98-95-3	< 330	330
Isophorone	78-59-1	< 330	330
2-Nitrophenol	88-75-5	< 330	330

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. BLANK070290

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
2,4-Dimethylphenol	105-67-9	< 330	330
Benzoic Acid	65-85-0	<1,600	1,600
bis(2-chloroethoxy) Methane	111-91-1	< 330	330
2,4-Dichlorophenol	120-83-2	< 330	330
1,2,4-Trichlorobenzene	120-82-1	< 330	330
Naphthalene	91-20-3	< 330	330
4-Chloroaniline	106-47-8	< 330	330
Hexachlorobutadiene	87-68-3	< 330	330
4-Chloro-3-methylphenol	59-50-7	< 330	330
2-Methylnaphthalene	91-57-6	< 330	330
Hexachlorocylopentadiene	77-47-4	< 330	330
2,4,6-Trichlorophenol	88-06-2	< 330	330
2,4,5-Trichlorophenol	95-95-4	<1,600	1,600
2-Chloronaphthalene	91-58-7	< 330	330
2-Nitroaniline	88-74-4	<1,600	1,600
Dimethyl Phthalate	131-11-3	< 330	330
Acenaphthylene	208-96-8	< 330	330
3-Nitroaniline	99-09-2	<1,600	1,600
Acenaphthene	83-32-9	< 330	330
2,4-Dinitrophenol	51-28-5	<1,600	1,600
4-Nitrophenol	100-02-7	<1,600	1,600
Dibenzofuran	132-64-9	< 330	330
2,4-Dinitrotoluene	121-14-2	< 330	330
2,6-Dinitrotoluene	606-20-2	< 330	330
Diethylphthalate	84-66-2	< 330	330
4-Chlorophenyl-phenylether	7005-72-3	< 330	330
Fluorene	86-73-7	< 330	330
4-Nitroaniline	100-01-6	<1,600	1,600
4,6-Dinitro-2-methylphenol	534-52-1	<1,600	1,600

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. BLANK070290

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
N-Nitrosodiphenylamine	86-30-6	< 330	330
4-Bromophenyl-phenylether	101-55-3	< 330	330
Hexachlorobenzene	118-74-1	< 330	330
Pentachlorophenol	87-86-5	<1,600	1,600
Phenanthrene	85-01-8	< 330	330
Anthracene	120-12-7	< 330	330
Di-n-Butylphthalate	84-74-2	< 330	330
Fluoranthene	206-44-0	< 330	330
Pyrene	129-00-0	< 330	330
Butylbenzylphthalate	85-68-7	< 330	330
3,3'-Dichlorobenzidine	91-94-1	< 660	660
Benzo(a)anthracene	56-55-3	< 330	330
bis(2-Ethylhexyl)phthalate	117-81-7	< 330	330
Chrysene	218-01-9	< 330	330
Di-n-Octyl Phthalate	117-84-0	< 330	330
Benzo(b)fluoranthene	205-99-2	< 330	330
Benzo(k)fluoranthene	207-08-9	< 330	330
Benzo(a)pyrene	50-32-8	< 330	330
Indeno(1,2,3-cd)pyrene	193-39-5	< 330	330
Dibenz(a,h)anthracene	53-70-3	< 330	330
Benzo(g,h,i)perylene	191-24-2	< 330	330

* Analyte detected but amount present is less than the Quantitation Limit.

Analytical Method: SW 846 Method 8270

Analyst: J. Rigdon
Verified: M. McGill
Date Reported: July 9, 1990

Respectfully submitted,

Environmental/Analytical Testing Division

Client: ATEC Environmental Services
Client Address: 2551 Eltham Avenue, Suite Z
Norfolk, VA 23513

Client Project Number: 26-08108
Client Sample Identification: C-6, Duplicate
Sample Matrix: Soil
Date Sample Collected: June 23, 1990
Date Sample Received: June 26, 1990
Date Sample Extracted: June 27, 1990
Dated Sample Analyzed: July 5, 1990
Analytical Equipment: Incos BS

SEMI-VOLATILE COMPOUNDS
ANALYTICAL RESULTS

ATEC Lab No. 9006241-6D

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Phenol	108-95-2	< 330	330
bis(2-Chloroethyl) Ether	111-44-4	< 330	330
2-Chlorophenol	95-57-8	< 330	330
1,3-Dichlorobenzene	541-73-1	< 330	330
1,4-Dichlorobenzene	106-46-7	< 330	330
Benzyl Alcohol	100-51-6	< 330	330
1,2-Dichlorobenzene	95-50-1	< 330	330
2-Methylphenol	95-48-7	< 330	330
bis(2-Chloroisopropyl Ether	39638-32-9	< 330	330
4-Methylphenol	106-44-5	< 330	330
N-Nitroso-Di-n-propylamine	621-64-7	< 330	330
Hexachloroethane	67-72-1	< 330	330
Nitrobenzene	98-95-3	< 330	330
Isophorone	78-59-1	< 330	330
2-Nitrophenol	88-75-5	< 330	330

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. 9006241-6D

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
2,4-Dimethylphenol	105-67-9	< 330	330
Benzoic Acid	65-85-0	<1,600	1,600
bis(2-chloroethoxy) Methane	111-91-1	< 330	330
2,4-Dichlorophenol	120-83-2	< 330	330
1,2,4-Trichlorobenzene	120-82-1	< 330	330
Naphthalene	91-20-3	< 330	330
4-Chloroaniline	106-47-8	< 330	330
Hexachlorobutadiene	87-68-3	< 330	330
4-Chloro-3-methylphenol	59-50-7	< 330	330
2-Methylnaphthalene	91-57-6	< 330	330
Hexachlorocylopentadiene	77-47-4	< 330	330
2,4,6-Trichlorophenol	88-06-2	< 330	330
2,4,5-Trichlorophenol	95-95-4	<1,600	1,600
2-Chloronaphthalene	91-58-7	< 330	330
2-Nitroaniline	88-74-4	<1,600	1,600
Dimethyl Phthalate	131-11-3	< 330	330
Acenaphthylene	208-96-8	< 330	330
3-Nitroaniline	99-09-2	<1,600	1,600
Acenaphthene	83-32-9	< 330	330
2,4-Dinitrophenol	51-28-5	<1,600	1,600
4-Nitrophenol	100-02-7	<1,600	1,600
Dibenzofuran	132-64-9	< 330	330
2,4-Dinitrotoluene	121-14-2	< 330	330
2,6-Dinitrotoluene	606-20-2	< 330	330
Diethylphthalate	84-66-2	< 330	330
4-Chlorophenyl-phenylether	7005-72-3	< 330	330
Fluorene	86-73-7	< 330	330
4-Nitroaniline	100-01-6	<1,600	1,600
4,6-Dinitro-2-methylphenol	534-52-1	<1,600	1,600

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. 9006241-6D

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
N-Nitrosodiphenylamine	86-30-6	< 330	330
4-Bromophenyl-phenylether	101-55-3	< 330	330
Hexachlorobenzene	118-74-1	< 330	330
Pentachlorophenol	87-86-5	<1,600	1,600
Phenanthrene	85-01-8	< 330	330
Anthracene	120-12-7	< 330	330
Di-n-Butylphthalate	84-74-2	< 330	330
Fluoranthene	206-44-0	< 330	330
Pyrene	129-00-0	< 330	330
Butylbenzylphthalate	85-68-7	< 330	330
3,3'-Dichlorobenzidine	91-94-1	< 660	660
Benzo(a)anthracene	56-55-3	< 330	330
bis(2-Ethylhexyl)phthalate	117-81-7	< 330*	330
Chrysene	218-01-9	< 330	330
Di-n-Octyl Phthalate	117-84-0	< 330	330
Benzo(b)fluoranthene	205-99-2	< 330	330
Benzo(k)fluoranthene	207-08-9	< 330	330
Benzo(a)pyrene	50-32-8	< 330	330
Indeno(1,2,3-cd)pyrene	193-39-5	< 330	330
Dibenz(a,h)anthracene	53-70-3	< 330	330
Benzo(g,h,i)perylene	191-24-2	< 330	330

* Analyte detected but amount present is less than the Quantitation Limit.

Analytical Method: SW 846 Method 8270

Analyst: J. Rigdon
Verified: M. McGill
Date Reported: July 9, 1990

Respectfully submitted,

Keith S. Kline

Environmental/Analytical Testing Division

Client: ATEC Environmental Services
Client Address: 2551 Eltham Avenue, Suite Z
Norfolk, VA 23513

Client Project Number: 26-08108
Client Sample Identification: C-15, Duplicate
Sample Matrix: Soil
Date Sample Collected: June 22, 1990
Date Sample Received: June 26, 1990
Date Sample Analyzed: July 2, 1990
Analytical Equipment: 1020A

VOLATILE COMPOUNDS ANALYTICAL RESULTS

ATEC Lab No. 9006241-15D

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Chloromethane	74-87-3	<10	10
Bromomethane	74-83-9	<10	10
Vinyl Chloride	75-01-4	<10	10
Chloroethane	75-00-3	<10	10
Methylene Chloride	75-09-2	14	5
Acetone	67-64-1	<10	10
Carbon Disulfide	75-15-0	< 5	5
1,1-Dichloroethene	75-35-4	< 5	5
1,1-Dichloroethane	75-35-3	< 5	5
Trans-1,2-Dichloroethene	156-60-5	< 5	5
Chloroform	67-66-3	< 5	5
1,2-Dichloroethane	107-06-2	< 5	5
2-Butanone	78-93-3	<10	10
1,1,1-Trichloroethane	71-55-6	< 5	5
Carbon Tetrachloride	56-23-5	< 5	5
Vinyl Acetate	108-05-4	<10	10
Bromodichloromethane	75-27-4	< 5	5
1,2-Dichloropropane	78-87-5	< 5	5

* Analyte detected but amount present is less than the Quantitation Limit.

ANALYTICAL RESULTS

ATEC Lab No. 9006241-15D

Analyte	CAS Number	Concentration (ug/kg)	Quantitation Limit (ug/kg)
Trans-1, 3-Dichloropropene	10061-02-6	< 5	5
Trichloroethene	79-01-6	< 5	5
Dibromochloromethane	124-48-1	< 5	5
1,1,2-Trichloroethane	79-00-5	< 5	5
Benzene	71-43-2	< 5*	5
cis-1,3-Dichloropropene	10061-01-5	< 5	5
2-Chloroethylvinylether	110-75-8	<10	10
Bromoform	75-25-2	< 5	5
4-Methyl-2-Pentanone	108-10-1	<10	10
2-Hexanone	591-78-6	<10	10
Tetrachloroethene	127-18-4	< 5	5
1,1,2,2-Tetrachloroethane	79-34-5	< 5	5
Toluene	108-88-3	< 5	5
Chlorobenzene	108-90-7	< 5	5
Ethylbenzene	100-41-4	< 5	5
Styrene	100-42-5	< 5	5
Total Xylenes		< 5	5

* Analyte detected but amount present is less than the Quantitation Limit.

Analytical Method: SW 846 Method 8240

Analyst: T. Harrison
Verified: M. McGill
Date Reported: July 2, 1990

Respectfully submitted,

Keith S. Kline

Environmental/Analytical Testing Division

9006291

ATEC
Environmental Consultants
Division of ATEC Associates of Va., Inc.
2551 Eltham Avenue, Suite Z • Norfolk, Virginia 23513-2511
(804) 857-6765, FAX # (804) 857-6283

CHAIN-OF-CUSTODY RECORD

C/C Control No 003
R/A Control No. 003

SAMPLING PROGRAM: WAB Commissary 26-08108
LAB DESTINATION: ATEC Indianapolis
SAMPLE TEAM MEMBERS: L. Glover
CARRIER/WAY BILL NO. 6258206776

Sample Number	Sample Location and Description	Date and Time Colelcted	Sample Type	Container Type	Condition on Receipt (Name and Date)	Disposal Record No.
C-1 '	monitoring well #1	6-23-90	Soil	4 oz teflon		
C-2 x	monitoring well #1	6-23-90	Soil	250 ml teflon		
C-3 '	monitoring well #2	6-23-90	Soil	4 oz teflon		
C-4 x	monitoring well #2	6-23-90	Soil	250 ml teflon		
C-5 '	monitoring well #3	6-23-90	Soil	4 oz teflon		
C-6 **	monitoring well #3	6-23-90	Soil	250 ml teflon		
C-7 '	monitoring well #4	6-21-90	Soil	4 oz teflon		
C-8 *	monitoring well #4	6-21-90	Soil	250 ml teflon		
C-9 '	monitoring well #5	6-21-90	Soil	4 oz teflon		
C-10 *	monitoring well #5	6-21-90	Soil	250 ml teflon		
C-11 '	monitoring well #4	6-23-90	Soil	4 oz teflon		
C-12 *	monitoring well #4	6-23-90	Soil	250 ml teflon		
C-13 '	monitoring well #7	6-22-90	Soil	4 oz teflon		
C-14 *	monitoring well #7	6-22-90	Soil	250 ml teflon		
C-15 '	monitoring well #8	6-22-90	Soil	4 oz teflon		

Special Instructions: analyze C-1, C-3, C-5, C-7, C-9, C-11, C-13 and C-15 for VOC 624; C-2, C-4, C-6, C-8, C-10, C-12, C-14 for BNA 625

Possible Sample Hazards: unknow

SIGNATURES: (Name, Company, Date and Time)

1. Relinquished By: [signature] ATEC 6-25-90 7:00
   Received By: [signature] Berger 6-26-90 10:40 am
2. Relinquished By:
   Received By
3. Relinquished By:
   Received By:
4. Relinquished By:
   Received By:

WHITE - To accompany samples
YELLOW - Field Copy

ATEC

Environmental Consultants

Division of ATEC Associates of Va., Inc.
2551 Eltham Avenue, Suite Z
Norfolk, Virginia 23512-2511
(804) 857-6765, FAX # (804) 857-6283

REQUEST FOR ANALYSIS 9006241

R/A Control No. 003
C/C Control No. No. 003

DATE SAMPLES SHIPPED 6-25-90
LAB DESTINATION ATEC Indianapolis
LABORATORY CONTACT Keith Kline
SEND LAB REPORT TO ATEC Environmental
2551 Eltham Ave
Suite Z
Norfolk, Virginia 23512

SAMPLING PROGRAM NAB Commissary

DATE REPORT REQUIRED 10 July 1990 (2weeks)
PROJECT CONTACT Lora Glover
PROJECT CONTACT PHONE NO. (804) 857-6765

PURCHASE ORDER NO. N/A

Sample Number	Sample Type	Sample Quantity	Preservative	Req't. Testing Program	Special Instructions
C-1	Soil	4oz teflon	N/A	VOC 624	
C-2	Soil	250ml teflon	N/A	BNA 625	
C-3	Soil	4oz teflon	N/A	VOC 624	
C-4	Soil	250ml teflon	N/A	BNA 625	
C-5	Soil	4oz teflon	N/A	VOC 624	
6-6	Soil	250 ml teflon	N/A	BNA 625	
C-7	Soil	4oz teflon	N/A	VOC 624	
C-8	Soil	250ml teflon	N/A	BNA 625	
C-9	Soil	4oz teflon	N/A	VOC 624	
C-10	Soil	250ml teflon	N/A	BNA 625	
C-11	Soil	4oz teflon	N/A	VOC 624	
C-12	Soil	250ml teflon	N/A	BNA 625	
C-13	Soil	4oz teflon	N/A	VOC 624	
C-14	Soil	250ml teflon	N/A	BNA 625	
C-15	Soil	4oz teflon	N/A	VOC 624	

TURNAROUND TIME REQUIRED: (Rush must be approved by appropriate Manager.) NORMAL ✓ RUSH____ (Subject to rush surcharge) 2wks.

POSSIBLE HAZARD IDENTIFICATION: (Please indicate if sample(s) are hazardous materials and/or suspected to contain high levels of hazardous substances.)

NONHAZARD____ FLAMMABLE____ SKIN IRRITANT____ HIGHLY TOXIC____ BIOLOGICAL____ OTHER Unknown (Please Specify)

SAMPLE DISPOSAL: (Please indicate disposition of sample following analysis.) RETURN TO CLIENT____ DISPOSAL BY LAB ✓

FOR LAB USE ONLY

RECEIVED BY [signature] DATE/TIME 6-26-90 10:40am

WHITE - Original, to accompany samples
YELLOW - Field Copy

ATEC

Environmental Consultants

Division of ATEC Associates of Va., Inc.
2551 Eltham Avenue, Suite Z • Norfolk, Virginia 23513-2511
(804) 857-6765, FAX # (804) 857-6283

CHAIN-OF-CUSTODY RECORD

9006241

C/C Control № 004

R/A Control No. № 004

SAMPLING PROGRAM: NAB Commissary

LAB DESTINATION: ATEC Indianapolis

SAMPLE TEAM MEMBERS: L. Glover & K Kegler

CARRIER/WAY BILL NO.: 6258206776

Sample Number	Sample Location and Description	Date and Time Colelcted	Sample Type	Container Type	Condition on Receipt (Name and Date)	Disposal Record No.
C-16 *	monitoring well #8	6-22-90	soil	250ml teflon		
SS-1 /	southern drainage ditch	6-25-90	soil	4oz teflon		
SS-2 *	Southern drainage ditch	6-25-90	soil	250ml teflon		
SS-3 /	eastern drainage ditch	6-25-90	soil	4oz teflon		
SS-4 *	eastern drainage ditch	6-25-90	soil	250ml teflon		
SS-5 /	northern drainage ditch	6-25-90	soil	4oz teflon		
SS-6 *	northern drainage ditch	6-25-90	soil	250ml teflon		

Special Instructions: analyze C-16, SS-2, SS-4, SS-6 for BNA 625 — SS-1, SS-3, SS-5 VOC 624

Possible Sample Hazards: Unknown

SIGNATURES: (Name, Company, Date and Time)

1. Relinquished By: [signature] ATEC 6-25-90 7:00

   Received By: [signature] 6-26-90 10:40 Am

2. Relinquished By:

   Received By:

3. Relinquished By:

   Received By:

4. Relinquished By:

   Received By:

WHITE - To accompany samples
YELLOW - Field Copy
PINK - Other

ARMADA/HOFFLER
CONSTRUCTION COMPANY

0100-R0100
JAN 6 7 15 AM 92

December 30, 1991

Ms. Barbara Wilt
Officer in Charge of Construction
Building 3175
Naval Amphibious Base, Little Creek
Norfolk, Virginia 23521-5147

Re: Little Creek Commissary, 90-C-0142
Virginia Beach, Virginia
Project #525-2513

Dear Ms. Wilt:

We have received CDR Powers letter of 20 Dec 91 and have stopped all earthwork related items on site. At this time we are continuing with submittals; "off-site" electrical work which is ready for cutover; and telephone cables and splicing. Additionally as soon as the electrical and telephone cutover occurs we plan on removing the abandoned poles and wire on the building site. When we receive sufficient material to proceed with the 4" overhead steam line, we plan on accomplishing this work unless the Navy directs otherwise.

Additionally we submitted the schedule of values and progress schedule 24 Dec 91.

We note your comments on taking measures to mitigate costs. With the limited work on site at this time, and with decisions expected approximately 1 Feb 92 we are not sure what significant mitigation can be done. The costs we expect to incur during this shut down will be our superintendent and CQC along with the trailers and port-a-johns. We have advised the earthwork subcontractor to demobilize and he understands that idle equipment he chooses to leave on site will not be reimbursed.

As you are aware, the foundation reinforcing steel was delivered the day of the shutdown. We anticipate other material such as structural steel will complete fabrication and some be delivered by 1 Feb 92. While we can possibly delay having it shipped to the site for a week or so, any prolonged delivery delays might result in companies wanting to get paid for material "stored off site" and possibly some storage charges.

My superintendent mentioned that a Navy civilian on site with you last week mentioned we shouldn't put the 10 loads of sand being delivered in place to fill undercuts "because we might just have to dig it all out", so we stockpiled it in the future parking lot. This statement brings up a question in that if it is determined in the future that significant soil will be dug from the site and replaced, then there is the possibility that the bottom of column pads will be deeper to rest on undisturbed soil and perhaps the Navy/Structural Engineer may want longer columns. This could be a problem because the columns have been ordered from Bethlehem cut to length and piers might be required.

Sincerely,

ARMADA/HOFFLER CONSTRUCTION COMPANY

K.S. Socie for Tom D. Best
Project Manager

NOT A Problem KAW

TDB/dlk

pc: Chris A. Sanders
Alan Hunt
Fletcher Frye

DEPARTMENT OF THE NAVY
OFFICER IN CHARGE OF CONSTRUCTION
RESIDENT OFFICER IN CHARGE OF CONSTRUCTION
NAVAL FACILITIES ENGINEERING COMMAND CONTRACTS
BUILDING NO. 3175
NAVAL AMPHIBIOUS BASE
LITTLE CREEK NORFOLK, VIRGINIA 23521-5147

IN REPLY REFER TO:

ROICC LITTLE CREEK
FACSIMILE TRANSMISSION COVER SHEET

Total Number of Pages Including Cover Sheet	Date
12	1/2/91

TO:	FROM:
Agency: LD / ~~[illegible]~~ PM	Agency: ROICC/OICC LITTLE CREEK
Name: ~~Jesse Kolte~~ LeAnn Rapp	Name: BARBARA WILT
Code: ~~18~~ 09A2134	Code: AROICC
Fax No:	Telephone: (804) 464-7713

90-0142

REMARKS:

TEST RESULTS ON WATER SAMPLES TAKEN FROM THE TWO OLD COAL PITS ON THE COMMISSARY SITE. THE RESULTS ON THE SLUDGE SAMPLE ARE NOT HERE YET.

(COPY ALSO FAXED TO JESSE KOLTE)

Barb

ROICC LITTLE CREEK FACSIMILE TELEPHONE NO: (804) 464-7878

Quality Performance... Quality Results

FACSIMILE TRANSMISSION COVER SHEET

TOTAL NUMBER OF PAGES INCLUDING COVER SHEET: 11 DATE: 1-2-92

TO:		FROM:	
AGENCY	Little Creek	AGENCY	LABORATORY DIVISION
NAME	Barbara Wilt	NAME	Carolyn Vidrine
CODE		CODE	930
Fax: 464-7878		TELEPHONE NUMBER	445-8850 or 445-8851

REMARKS:

The following data sheets are completed Results for TCLP for the two liquid samples labeled Hopper A & B.

FACSIMILE MACHINE: MURATA F-55 / TELEPHONE: (804) 445-8852, Autovon 565-8850

NAVY PUBLIC WORKS CENTER
ENVIRONMENTAL DEPARTMENT
LABORATORY DIVISION
NORFOLK, VIRGINIA 23511-6098

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12680 MCMANUS BOULEVARD SUITE 4
NEWPORT NEWS, VA 23602
(804)874-4930

CERTIFICATE OF ANALYSIS

Navy Public Works Center
Environmental Department
Bldg. Z140
Norfolk, VA 23511-6098

Attn.: Merrill Ashcraft

DATE: December 31, 1991

LOCATION: Little Creek Coal Hopper A

DATE/TIME RECEIVED: 12/13/91 @ 1438

LABORATORY I.D.#: 1291 358
SAMPLER: Navy Lab Personnel
DATE/TIME SAMPLED: 12/13/91 @ Not Provided

ANALYSIS	SAMPLE NUMBER	METHOD/MDL	RESULT	ANALYST	DATE/TIME ANALYZED
TCLP METALS	1412				
Arsenic		7060/0.005	0.014 mg/L	K. Watkins	12/17/91 @ 0900
Selenium		7740/0.005	0.17 mg/L	P. Jeffrey	12/23/91 @ 1200
Barium		7080/0.2	<0.2 mg/L	P. Jeffrey	12/17/91 @ 1100
Cadmium		7130/0.04	0.04 mg/L	P. Jeffrey	12/16/91 @ 1445
Chromium		7190/0.3	0.3 mg/L	P. Jeffrey	12/17/91 @ 1000
Lead		7420/0.1	<0.1 mg/L	P. Jeffrey	12/30/91 @ 1630
Silver		7760/0.04	<0.04 mg/L	P. Jeffrey	12/17/91 @ 1330
Mercury		7470/0.001	<0.001 mg/L	M. Skrob.	12/17/91 @ 1025
Phenolics		420.2/0.01	0.03 mg/L	M. Day	12/21/91 @ 1615
Volatiles			See Attached		
TCLP BNA			See Attached		
TCLP Pesticides/Herbicides			See Attached		
TCLP Volatiles			See Attached		

Respectfully Submitted,

Carol J Pollard

Carol J. Pollard
Laboratory Di...

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12650 MCMANUS BOULEVARD SUITE 4
NEWPORT NEWS, VA 23602
(804)874-4930

CERTIFICATE OF ANALYSIS

DATE: December 31, 1991

CLIENT: Navy Public Works Center/N62470-90-B-4695

LABORATORY#: 1291 358

SAMPLE #: 1412 - Little Creek Coal Hopper A

ANALYST: M. S. Makowiecki

DATE/TIME ANALYZED: 12/19/91 @ 1634

TCLP VOLATILE ORGANIC COMPOUNDS-EPA METHOD 8240

COMPOUND	CONCENTRATION ug/L (ppb)	MDL ug/L (ppb)	REGULATORY LIMIT mg/L (ppm)
Benzene	<5	5	0.5
Carbon Tetrachloride	<5	5	0.5
Chlorobenzene	<5	5	100.0
Chloroform	<5	5	6.0
1,2-Dichloroethane	<5	5	0.5
1,1-Dichloroethylene	<5	5	0.7
Methyl Ethyl Ketone	<100	100	200.0
Tetrachloroethylene	<5	5	0.7
Trichloroethylene	<5	5	0.5
Vinyl Chloride	<10	10	0.2

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12658 MCMANUS BOULEVARD SUITE 4
NEWPORT NEWS, VA 23602
(804)874-4938

CERTIFICATE OF ANALYSIS

DATE: December 31, 1991

CLIENT: Navy Public Works Center/N62470-90-B-4695

LABORATORY#: 1291 358

SAMPLE #: 1412 - Little Creek Coal Hopper A

ANALYST: A. S. Viertel

DATE/TIME ANALYZED: 12/23/91 @ 1345

TCLP PESTICIDES & HERBICIDES-EPA METHOD 8080

COMPOUND	CONCENTRATION mg/L (ppm)	MDL mg/L (ppm)	REGULATORY LIMIT mg/L (ppm)
HERBICIDES			
2,4-D	<0.025	0.025	10.0
2,4,5-TP (Silvex)	<0.0025	0.0025	1.0
PESTICIDES			
Lindane	<0.0025	0.0025	0.4
Endrin	<0.0025	0.0025	0.02
Methoxychlor	<0.025	0.025	10.0
Toxaphene	<0.025	0.025	0.5
Chlordane	<0.025	0.025	0.03
Heptachlor	<0.0025	0.0025	0.008
Heptachlor Epoxide	<0.0025	0.0025	0.008

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12650 MCMANUS BOULEVARD SUITE 4
NEWPORT NEWS, VA 23602
(804)874-4930

CERTIFICATE OF ANALYSIS

DATE: December 31, 1991

CLIENT: Navy Public Works Center/N62470-90-B-4695

LABORATORY#: 1291 358

SAMPLE #: 1412 - Little Creek Coal Hopper A

ANALYST: A. S. Viertel

DATE/TIME ANALYZED: 12/23/91 @ 1746

TCLP SEMIVOLATILE BASE/NEUTRAL EXTRACTABLE COMPOUNDS
EPA METHOD 8270

COMPOUND	CONCENTRATION mg/L (ppm)	MDL mg/L (ppm)	REGULATORY LIMIT mg/L (ppm)	% SPIKE RECOVERY
1,4-Dichlorobenzene	<0.05	0.05	7.5	108%
2,4-Dinitrotoluene	<0.05	0.05	0.13	84%
Hexachlorobenzene	<0.05	0.05	0.13	126%
Hexachloroethane	<0.05	0.05	3.0	111%
Hexachlorobutadiene	<0.05	0.05	0.5	109%
Nitrobenzene	<0.05	0.05	2.0	101%
Pyridine	<0.05	0.05	5.0	115%

TCLP SEMIVOLATILE ACID EXTRACTABLE COMPOUNDS
EPA METHOD 8270

COMPOUND	CONCENTRATION mg/L (ppm)	MDL mg/L (ppm)	REGULATORY LIMIT mg/L (ppm)	% SPIKE RECOVERY
o-Cresol	<0.05	0.05	200.0	119%
m-Cresol	<0.05	0.05	200.0	107%
p-Cresol	<0.05	0.05	200.0	107%
Pentachlorophenol	<0.25	0.25	100.0	125%
2,4,5-Trichlorophenol	<0.25	0.25	400.0	101%
2,4,6-Trichlorophenol	<0.05	0.05	2.0	109%

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12650 MCMANUS BOULEVARD SUITE 4
NEWPORT NEWS, VA 23602
(804)874-4930

CERTIFICATE OF ANALYSIS

DATE: December 31, 1991
CLIENT: Navy Public Works Center/N62470-90-B-4695
LABORATORY #: 1291 358
SAMPLE #: 1412 - Little Creek Coal Hopper A
ANALYST: M.S. Makowieski
DATE/TIME ANALYZED: 12/19/91 @ 1634

TABLE IV

PARAMETER	MDL	RESULT(ug/L)
VOLATILE ORGANIC COMPOUNDS		
Benzene	5	<5
Bromodichloromethane	5	<5
Bromoform	5	<5
Bromomethane	10	<10
Carbon Tetrachloride	5	<5
Chlorobenzene	5	<5
Chloroethane	10	<10
2-chloroethylvinyl ether	10	<10
Chloroform	5	<5
Chloromethane	10	<10
Dibromochloromethane	5	<5
1,2-Dichlorobenzene	5	<5
1,3-Dichlorobenzene	5	<5
1,4-Dichlorobenzene	5	<5
1,1-Dichloroethane	5	<5
1,2-Dichloroethane	5	<5
1,1-Dichloroethene	5	<5
trans-1,2-Dichloroethene	5	<5
1,2-Dichloropropane	5	<5
cis-1,3-Dichloropropene	5	<5
trans-1,3-Dichloropropene	5	<5
Ethylbenzene	5	<5
Methylene Chloride	5	<5
1,1,2,2-Tetrachloroethane	5	<5
Tetrachloroethene	5	<5
Toluene	5	<5
1,1,1-Trichloroethane	5	<5
1,1,2-Trichloroethane	5	<5
Trichloroethene	5	<5
Trichlorofluoromethane	5	<5
Vinyl Chloride	10	<10
Acetone	100	<100
Carbon Disulfide	5	<5
2-Butanone	100	<100
Vinyl Acetate	50	<50
4-Methyl-2-Pentanone	50	<50
2-Hexanone	50	<50
Styrene	5	<5
Xylenes	5	<5

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12650 MCMANUS BOULEVARD SUITE 6
NEWPORT NEWS, VA 23602
(804)874-8930

CERTIFICATE OF ANALYSIS

Navy Public Works Center
Environmental Department
Bldg. Z140
Norfolk, VA 23511-6098

Attn.: Merrill Ashcraft

DATE: December 31, 1991

LOCATION: Little Creek Coal Hopper B

DATE/TIME RECEIVED: 12/13/91 @ 1438

LABORATORY I.D.#: 1291 359
SAMPLER: Navy Lab Personnel
DATE/TIME SAMPLED: 12/13/91 @ Not Provided

ANALYSIS	SAMPLE NUMBER	METHOD/MDL	RESULT	ANALYST	DATE/TIME ANALYZED
TCLP METALS	1413				
Arsenic		7060/0.05	<0.05 mg/L	K. Watkins	12/17/91 @ 0900
Selenium		7740/0.05	<0.05 mg/L	P. Jeffrey	12/23/91 @ 1200
Barium		7080/0.2	<0.2 mg/L	P. Jeffrey	12/17/91 @ 1100
Cadmium		7130/0.04	0.04 mg/L	P. Jeffrey	12/17/91 @ 1000
Chromium		7190/0.3	0.2 mg/L	P. Jeffrey	12/16/91 @ 1445
Lead		7420/0.1	<0.1 mg/L	P. Jeffrey	12/30/91 @ 1630
Silver		7760/0.04	<0.04 mg/L	P. Jeffrey	12/17/91 @ 1330
Mercury		7470/0.0005	<0.0005mg/L	M. Skrob.	12/17/91 @ 1025
Phenolics		420.2/0.05	0.06 mg/L	M. Day	12/21/91 @ 1615

Volatiles	See Attached
TCLP BNA	See Attached
TCLP Pesticides/Herbicides	See Attached
TCLP Volatiles	See Attached

Respectfully Submitted,

Carol J. Pollard

Carol J. Pollard
Laboratory Director

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12650 MCMANUS BOULEVARD SUITE 6
NEWPORT NEWS, VA 23602
(804)874-4930

CERTIFICATE OF ANALYSIS

DATE: December 31, 1991

CLIENT: Navy Public Works Center/N62470-90-B-4695

LABORATORY#: 1291 359

SAMPLE #: 3413 - Little Creek Coal Hopper B

ANALYST: M. S. Makowiecki

DATE/TIME ANALYZED: 12/19/91 @ 1701

TCLP VOLATILE ORGANIC COMPOUNDS-EPA METHOD 8240

COMPOUND	CONCENTRATION ug/L (ppb)	MDL ug/L (ppb)	REGULATORY LIMIT mg/L (ppm)
Benzene	<5	5	0.5
Carbon Tetrachloride	<5	5	0.5
Chlorobenzene	<5	5	100.0
Chloroform	<5	5	6.0
1,2-Dichloroethane	<5	5	0.5
1,1-Dichloroethylene	<5	5	0.7
Methyl Ethyl Ketone	<100	100	200.0
Tetrachloroethylene	<5	5	0.7
Trichloroethylene	<5	5	0.5
Vinyl Chloride	<10	10	0.2

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12650 MCMANUS BOULEVARD SUITE 4
NEWPORT NEWS, VA 23602
(804)874-4930

CERTIFICATE OF ANALYSIS

DATE: December 31, 1991

CLIENT: Navy Public Works Center/N62470-90-B-4695

LABORATORY#: 1291 389

SAMPLE #: 1413 - Little Creek Coal Hopper B

ANALYST: A. S. Viertel

DATE/TIME ANALYZED: 12/23/91 @ 1357

TCLP PESTICIDES & HERBICIDES-EPA METHOD 8080

COMPOUND	CONCENTRATION mg/L (ppm)	MDL mg/L (ppm)	REGULATORY LIMIT mg/L (ppm)
HERBICIDES			
2,4-D	<0.025	0.025	10.0
2,4,5-TP (Silvex)	<0.0025	0.0025	1.0
PESTICIDES			
Lindane	<0.002	0.002	0.4
Endrin	<0.002	0.002	0.02
Methoxychlor	<0.020	0.020	10.0
Toxaphene	<0.020	0.020	0.5
Chlordane	<0.020	0.020	0.03
Heptachlor	<0.002	0.002	0.008
Heptachlor Epoxide	<0.002	0.002	0.008

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12650 MCMANUS BOULEVARD SUITE 4
NEWPORT NEWS, VA 23602
(804)874-4930

CERTIFICATE OF ANALYSIS

DATE: December 31, 1991

CLIENT: Navy Public Works Center/N62470-90-B-4695

LABORATORY#: 1291 359

SAMPLE #: 1413 - Little Creek Coal Hopper B

ANALYST: A. S. Viertel

DATE/TIME ANALYZED: 12/23/91 @ 1001

TCLP SEMIVOLATILE BASE/NEUTRAL EXTRACTABLE COMPOUNDS
EPA METHOD 8270

COMPOUND	CONCENTRATION mg/L (ppm)	MDL mg/L (ppm)	REGULATORY LIMIT mg/L (ppm)
1,4-Dichlorobenzene	<0.05	0.05	7.5
2,4-Dinitrotoluene	<0.05	0.05	0.13
Hexachlorobenzene	<0.05	0.05	0.13
Hexachloroethane	<0.05	0.05	3.0
Hexachlorobutadiene	<0.05	0.05	0.5
Nitrobenzene	<0.05	0.05	2.0
Pyridine	<0.05	0.05	5.0

TCLP SEMIVOLATILE ACID EXTRACTABLE COMPOUNDS
EPA METHOD 8270

COMPOUND	CONCENTRATION mg/L (ppm)	MDL mg/L (ppm)	REGULATORY LIMIT mg/L (ppm)
o-Cresol	<0.05	0.05	200.0
m-Cresol	<0.05	0.05	200.0
p-Cresol	<0.05	0.05	200.0
Pentachlorophenol	<0.25	0.25	100.0
2,4,5-Trichlorophenol	<0.25	0.25	400.0

MICROBAC LABORATORIES, INC.
MID-ATLANTIC DIVISION
12650 MCMANUS BOULEVARD SUITE 6
NEWPORT NEWS, VA 23602
(804)874-4930

CERTIFICATE OF ANALYSIS

DATE: December 31, 1991
CLIENT: Navy Public Works Center/N62470-90-B-4695
LABORATORY #: 1291 359
SAMPLE #: 1413 - Little Creek Coal Hopper B
ANALYST: M.S. Makowieski
DATE/TIME ANALYZED: 12/19/91 @ 1701

TABLE IV

PARAMETER	MDL	RESULT(ug/L)
VOLATILE ORGANIC COMPOUNDS		
Benzene	5	<5
Bromodichloromethane	5	<5
Bromoform	5	<5
Bromomethane	10	<10
Carbon Tetrachloride	5	<5
Chlorobenzene	5	<5
Chloroethane	10	<10
2-chloroethylvinyl ether	10	<10
Chloroform	5	<5
Chloromethane	10	<10
Dibromochloromethane	5	<5
1,2-Dichlorobenzene	5	<5
1,3-Dichlorobenzene	5	<5
1,4-Dichlorobenzene	5	<5
1,1-Dichloroethane	5	<5
1,2-Dichloroethane	5	<5
1,1-Dichloroethene	5	<5
trans-1,2-Dichloroethene	5	<5
1,2-Dichloropropane	5	<5
cis-1,3-Dichloropropene	5	<5
trans-1,3-Dichloropropene	5	<5
Ethylbenzene	5	<5
Methylene Chloride	5	<5
1,1,2,2-Tetrachloroethane	5	<5
Tetrachloroethene	5	<5
Toluene	5	<5
1,1,1-Trichloroethane	5	<5
1,1,2-Trichloroethane	5	<5
Trichloroethene	5	<5
Trichlorofluoromethane	5	<5
Vinyl Chloride	10	<10
Acetone	100	<100
Carbon Disulfide	5	<5
2-Butanone	100	<100
Vinyl Acetate	50	<50
4-Methyl-2-Pentanone	50	<50
2-Hexanone	50	<50
Styrene	5	<5
Xylenes	5	<5

DEPARTMENT OF THE NAVY
NAVAL AMPHIBIOUS BASE, LITTLE CREEK
NORFOLK, VIRGINIA 23521-5000

Remedial CONTRACT MANAGER

11010
Ser N492/

From: Commanding Officer, Naval Amphibious Base Little Creek
To: Resident Officer in Charge of Construction, Little Creek

Subj: WASTE WATER SAMPLING REQUIREMENTS FOR DEWATERING OPERATIONS AT COMMISSARY, N62470-90-C0142

Ref: (a) LANTNAVFACENGCOM ltr 6280/1812:CHW of 30 Dec 91

Encl: (1) Hampton Roads Sanitation District Industrial Wastewater Discharge Permit Monitoring Requirements
(2) Hampton Roads Sanitation District Industrial Wastewater Discharge Permit Effluent Limitations

1. As requested in reference (a), Hampton Roads Sanitation District (HRSD) has modified Naval Amphibious Base, Little Creek's (NAB Little Creek) Industrial Wastewater Discharge Permit to include de-watering operations associated with the Commissary Project, MILCON P-425. To comply with the permit requirements in enclosures (1) and (2), the contractor must provide the following data:

a. The Environmental Branch (N492) must be notified 72 hours prior to start up of discharge pretreatment.

b. HRSD must be notified at least 48 hours prior to start up of discharge pretreatment.

c. The following sampling regime and reporting requirements will be followed for the dewatering discharge process:

(1) One sample will be collected each week (7 calendar days) of the dewatering process at the discharge point to the sewer system. The first sample will be a grab sample collected on the first day of discharge and analyzed in accordance with Effluent Parameters provided in enclosure (2). Upon notification by HRSD, sampling methods and frequency may change (i.e. HRSD may require composite samples).

(2) Lab analysis must be submitted to HRSD and NAB Little Creek within seven (7) calendar days of sample collection. Contractor must notify NAB Little Creek and HRSD immediately of ANY permit violation.

Subj: WASTE WATER SAMPLING REQUIREMENTS FOR DEWATERING OPERATIONS AT COMMISSARY, N62470-90-C0142

(3) Contractor must submit a weekly discharge report to NAB Little Creek, providing the daily discharge rate. The discharge flow will not exceed 9000 GPD (daily maximum) while the calendar monthly average will not exceed 5000 GPD.

2. Additionally, request you ensure the contractor has received any necessary approval from the Department of Air Pollution Control regarding air emissions standards. My point of contact for further information regarding the HRSD permit is Dr. Lewis Affronti at 363-4006.

William C. Th

Daily discharge metering

Copy to:
LANTNAVFACENGCOM

HAMPTON ROADS SANITATION DISTRICT

INDUSTRIAL WASTEWATER DISCHARGE PERMIT

(MONITORING AND METERING REQUIREMENTS) **Addendum (1/29/92)**

Permit No. **0102**

Monitoring Requirements: **with Section 402 of HRSD's Industrial Wastewater Discharge Regulations. One (1) weekly sample shall be collected from the discharge from the Commissary construction dewatering air-stripping operation starting on the first day of discharge and analyzed for pH and the six (6) organic compounds listed on Page II-E of this Permit. The first day's results shall be submitted to HRSD within seven (7) days of the first sampling date.**

Metering Requirements: **Metering for billing purposes shall be four (4) effluent flow meters: 1) Pump Station #3879 - BOD Model #0172-01, 2) Pump Station #751 - BOF Model #0172-01, 3) Pump Station #1518 - Fischer-Porter Model #51-1102D, 4) Pump Station #2115 - Fischer-Porter Model #51-1102-D. These meters shall be certified as accurate to manufacturer's specifications no less frequently than annually. A copy of these certifications shall be forwarded to HRSD within thirty (30) days of certification date.**

ORIGINAL

HAMPTON ROADS SANITATION DISTRICT

HAMPTON ROADS SANITATION DISTRICT

INDUSTRIAL WASTEWATER DISCHARGE PERMIT

(EFFLUENT LIMITATIONS) **Addendum (1/29/92)**

Permit No. **0102**

The following referenced parameters are known to exist in the permittee's discharge through information provided in the permit application. The limitations set forth below shall be met at all times. In addition, all other effluent limitations and general discharge prohibitions set forth in the Hampton Roads Sanitation District's Industrial Wastewater Discharge Regulations and all applicable Federal and State limitations shall be met.

COMMISSARY DEWATERING

PARAMETER	LIMITATIONS: CALENDAR MO. AVERAGE* (mg/l)	LIMITATIONS: CALENDAR DAY MAXIMUM** (mg/l)
Arsenic (As)		
Cadmium (Cd)		
Chromium, Total (Cr)		
Copper (Cu)		
Cyanide (CN-)		
Lead (Pb)		
Mercury (Hg)		
Nickel (Ni)		
Phenolic Compounds		
Silver (Ag)		
***Oil & Grease (Non-Saponifiable)		
pH	>=5.0 AND <= 12.5 *	>=5.0 AND <= 12.5
Flow	5000 GPD	9000 GPD
Tetrachloroethane@	1.0	1.0
Trichloroethene@	1.0	1.0
Vinylchloride@	1.0	1.0
Trans 1,2-Dichloroethene@	1.0	1.0
TTO (Total Toxic Organics including all @)	2.13	2.13
Dichlorodifluoromethane@	1.0	1.0
1,1,1-Trichloromethane@	1.0	1.0

* Average of any number of daily values obtained during a calendar month.

** Maximum for any sample obtained during any calendar day.

*** There shall be no visible free oil present.

* ANY EFFLUENT W/ pH >12.5 MAY BE CONSIDERED A HAZARDOUS WASTE [illegible] HARM TO HRSD OPERATIONS.

ORIGINAL

(1) 405 JB
(2) 411
(3) 04

04D

(804) 445-2930

6280
1812:CHW

20 DEC 1991

Mr. Guy Aydlett
Chief, Industrial Waste Division
Hampton Roads Sanitation District
P.O. Box 5000
Virginia Beach, Virginia 23455

Re: Construction Contract N62470-90-C0142, Commissary, Naval Amphibious Base (NAVPHIBASE), Little Creek

Dear Mr. Aydlett:

As we discussed previously, site work has begun for construction of a new Commissary at NAVPHIBASE Little Creek located over contaminated groundwater. Site investigations have been conducted on the soil and groundwater. Data from monitoring wells at and around the construction site indicates contamination of the groundwater with several solvents used in the past at a former dry cleaning plant. Monitoring well data, site location maps, etc., are enclosed for your review.

Site dewatering is required for construction of both interior and exterior utilities. Reasonable steps will be taken during construction to minimize the amount of dewatering required (i.e., elevating storm and sanitary levels). The Tidewater Regional Office of the State Water Control Board has informed us via the enclosed letter dated December 19, 1991, that in order for us to discharge this contaminated groundwater to a storm sewer a modification to the NAVPHIBASE Little Creek Virginia Pollutant Discharge Elimination System (VPDES) permit will be necessary. This modification is expected to take at least 120 days. Since the construction contractor for the Commissary may be prevented from dewatering until this issue can be resolved (estimated cost to the Navy of approximately $1,500 per day), we do not feel this is a feasible groundwater disposal alternative.

We propose to have the construction contractor route the discharge from dewatering after air stripping into the NAVPHIBASE Little Creek sanitary sewer system at the construction site. Sewage from this area ultimately flows through Pump Station No. 3879 to your Chesapeake-Elizabeth Plant under Industrial Wastewater Discharge Permit No. 0102. The current construction schedule involves no more than 45 days of dewatering with an estimated maximum volume of 150,000 gallons (5000 gallons per day average). The expected maximum level of contamination prior to air stripping are the levels identified in Monitoring Well No. 2.

Re: Construction Contract N62470-90-C0142, Commissary, Naval Amphibious Base (NAVPHIBASE), Little Creek

The total volume of contaminated groundwater pumped to the base sanitary sewer system, and dates of discharge will be forwarded to your office by the NAVPHIBASE Little Creek Resident Officer in Charge of Construction Office (ROICC) once the dewatering is completed.

As the contract has been awarded and the contractor is ready to proceed with site utilities, your earliest response is requested and appreciated. Please contact Mr. Paul Rakowski directly at 445-2930 for any further questions.

Sincerely,

W. H. RUSSELL, P.E.
Director
Environmental Quality Division
By direction of the Commander

Encl:
(1) Site Vicinity and Monitoring Well Maps & Groundwater Data

Copy to:
NAVPHIBASE Little Creek
ROICC Little Creek

Blind copy to:
09A
04
05
09A2
18
182
181
1812
18S
LANTDIV Reading File
CHWDoc:commltr.pbp

COMMONWEALTH of VIRGINIA

STATE WATER CONTROL BOARD
2111 Hamilton Street

Richard N. Burton
Executive Director

Post Office Box 11143
Richmond, Virginia 23230-1143
(804) 367-0056
TDD (804) 367-9763

Please reply to: Tidewater Regional Office
287 Pembroke Office Park
Suite 310 Pembroke No. 2
Virginia Beach, Virginia 23462-2956
(804) 552-1840

December 19, 1991

Mr. Paul A. Rakowski, P. E.
Head, Environmental Programs Branch
Environmental Quality Division
Department of the Navy
Atlantic Division Naval Facilities
Engineering Command
Norfolk, Virginia 23511-6287

RE: Commissary Construction - Site Dewartering Disposal
Little Creek Naval Amphibious Base - Norfolk, VA
VPDES Permit No. VA0079928

Dear Mr. Rakowski:

This is in response to your letter dated December 16, 1991 regarding the construction of a new commissary at Naval Amphibious Base Little Creek. It is understood that site dewatering is necessary in order to continue construction, however disposal of construction site dewatering is a concern due to initial monitoring results which indicate contamination of the groundwater. Knowing that contamination is present, a discharge to surface waters of this effluent would need to be recognized in your VPDES Permit through a permit modification. The time period for processing a modification request would be not less that 120 days from the receipt of a complete modification request.

If you have any questions regarding this matter please contact me at our Virginia Beach office.

Sincerely,

Debra L. Thompson

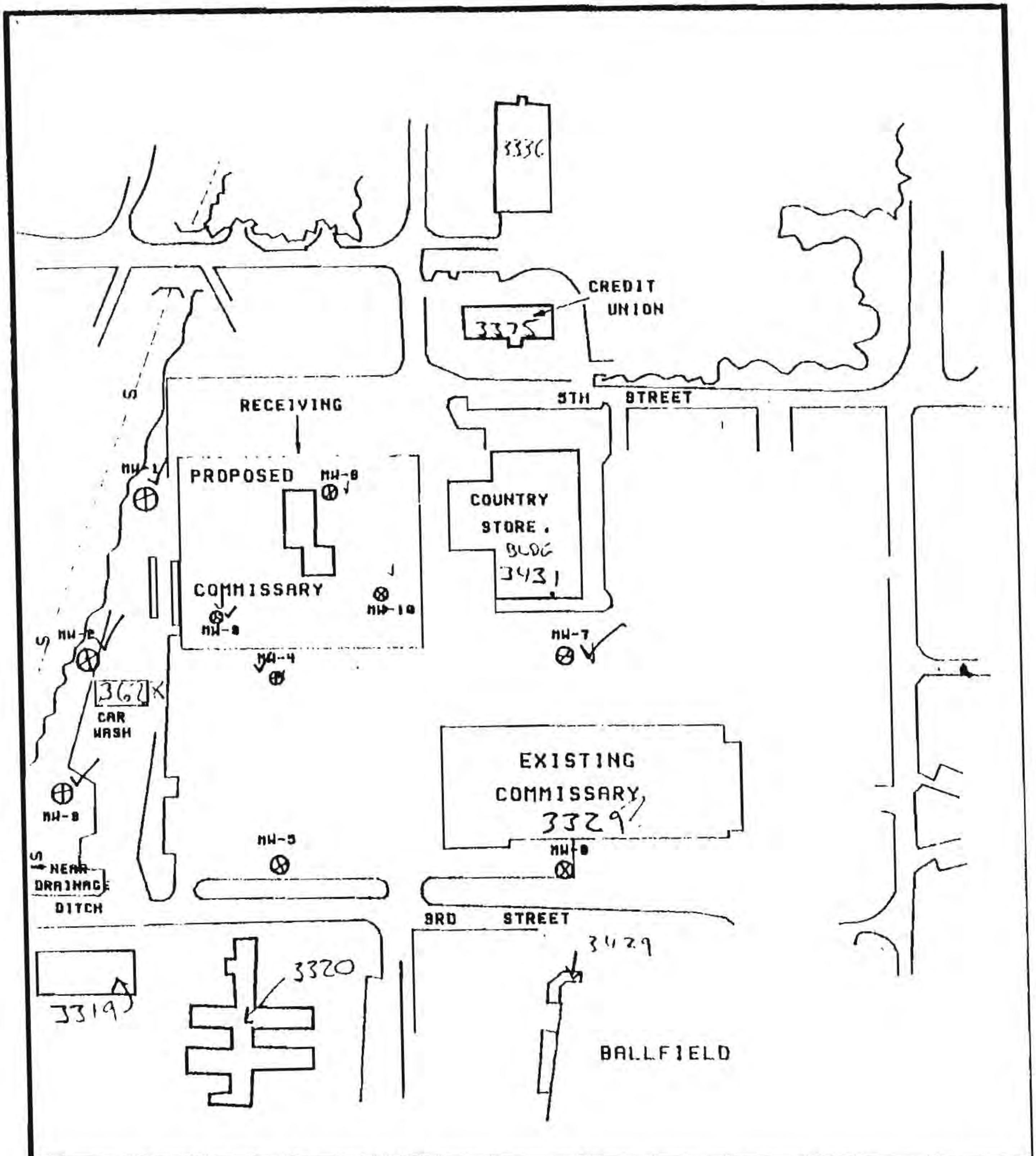
Debra L. Thompson
Environmental Engineer

cc: SWCB - TRO
Dept. of Waste Management

ATEC Associates
OF VIRGINIA, INC.

FIGURE 1: SITE VICINITY MAP

Job Name: NAB COMMISSARY SITE
Job No: 26-17391
Client: BRUNDAGE, KROSKIN AND ASSOCIATES
Date: April 22,1991



ATEC ENVIRONMENTAL	SITE DESCRIPTION MAP
	PROJECT: NAB COMMISSARY SITE — FIGURE 2
	JOB NO: 26-17391 — DRAWN BY: RPY
	CLIENT: BRUNDAGE, KROSIN & ASSOC.
	DATE: APRIL 19, 1991 — NOT TO SCALE

ATEC Environmental Consultants
Division of ATEC Associates of VA, Inc
2551 Eltham Avenue, Suite Z
Norfolk, Virginia 23513
(804) 857-6765, FAX # (804) 857-6283

Solid & Hazardous Waste Site Assessments
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Underground Tank Management
Asbestos Surveys & Analysis
Hydrogeologic Investigations & Monitoring
Analytical Testing / Chemistry
Industrial Hygiene / Hazard Communication
Environmental Audits & Permitting
Exploratory Drilling & Monitoring Wells

April 22, 1991

Kroskin Design Group PC
6160 Kempsville Circle, Suite 310 A
Norfolk, VA 23502

Attention: Mr. Irwin Kroskin

RE: Phase II Environmental Site Study
NAB Commissary Site
Virginia Beach, Virginia
ATEC Project Number: 26 17391

Dear Mr. Kroskin:

ATEC Environmental Consultants appreciates this opportunity to conduct a soil and water sampling program of the NAB Commissary Site, on the Little Creek Amphibious Base located in Virginia Beach, Virginia. The purpose of this assessment is to verify initial findings noted in ATEC's Phase II Site Assessment dated August 1, 1990 and to address the concerns that contamination exists in the area of the new building location.

Enclosed is a report documenting all activities performed at the site, providing an interpretation of all generated data, and stating conclusions with regard to the overall environmental conditions at the site.

This assessment has been conducted in a manner to satisfy the client. If there are any questions, please contact this office.

Respectfully Submitted,

ATEC ENVIRONMENTAL CONSULTANTS

Lora B. Glover
Geologist

Roland E. Dubbe', P.E.
Vice President/District Manager

LBG/RED/plg

PHASE II ENVIRONMENTAL SITE STUDY
NAB COMMISSARY SITE
VIRGINIA BEACH, VIRGINIA
ATEC PROJECT NUMBER: 26-17391

FOR

E ... ATES

4 Kroskin Design Group PC

N 6160 Kempsville Circle, Suite 310 A
Norfolk, VA 23502

A

3.0 ANALYTICAL RESULTS

The sampling program conducted for this project produced a discrete set of analytical chemical data which is included in Appendix C. The significance of each data set is discussed below. A parameter know as the Quantitation Detection Limit refers to the lower limit beyond which chemical components can not be detected by standard analytical procedures. While the limits for most parameters are quite sensitive, current analytical capabilities cannot be warranted to detect chemical components below these levels.

The sampling and analysis program for this project was developed and inplemented within the Quality Assurance/Quality Control (QA/QC) Standards established by ATEC Associates, Environmental Division. This plan is available upon request.

Soil samples that were collected during the well installation, were laboratory analyzed for VOCs using EPA Method 601. Two contaminants (Methylene Chloride and Chloroform) were reported but have been attributed to laboratory contamination. A small amount of a cleanser for metals and plastics, 1,1,1 Trichloromethane,was also detected in the two soil samples and the laboratory QA/QC samples (purge blank). A purge blank is used as a QA/QC for verifying the accuracy of the laboratory procedures. Since this contaminate was present in the purge blank, the validity of this compound in the remaining samples is inconclusive.

The water samples collected from the ten wells were analyzed for VOCs using EPA Method 601. Chloroform was in low concentrations detected in several water samples and the field blank (deionized water). Since this contaminant is common in laboratory solvent, it is ATEC's opinion that the detected concentration can be attributed to laboratory contamination. A table of the laboratory results for the concentration of dry cleaning solvents and their by products in the water samples are provided in Table 2.

TABLE 2: DRY CLEANING SOLVENT AND BYPRODUCTS

DRY CLEANING SOLVENT AND BYPRODUCTS (PPB)

Well Locations	Tetrachloroethane	Trichloroethene	Trans-1 2-Dichloroethene	Vinylchloride
MW2	470.0	160.0	NA	NA
MW4	4.0	6.5	NA	NA
MW6	NA	2.5	NA	NA
MW7	NA	13.0	NA	NA
MW9	16.0	3.0	NA	NA
MW10	4.7	2.8	NA	9.9
*MW11	NA	1.5	NA	NA
**MW12	440.0	150.0	NA	NA

*MW11 - Field Blank
** Duplicate Sample

Dry cleaning solvents and their by-products have been documented in water samples collected from on-site monitoring wells at the proposed location of the new Little Creek Commissary. The levels detected are above the recommended maximum concentration level for drinking water as established by the Federal Priority Pollutant Water Quality Criteria. The recommended levels are 0.0 mg/l for Vinly Chloride, Trichloroethene, and Tetrachloroethane, and 0.07 mg/l for Trans 1,2 Dichloroethylene.

These compounds are classified as hazardous waste according to the Chemical Substance Control Regulations published by the U.S. Bureau of National Affairs. The hazardous waste number for Trans-1,2-Dichloroethene is U079, for Tetrachloroethane U210; for Trichloroethene U228; and for Vinyl Chloride U048. The corresponding chemical abstract numbers were 156-60-5, 127-18-8, 79-01-6, and 75-01-4 respectively.

A duplicate sample was collected from MW2 and analyzed for VOCs. The duplicate sample results confirms the level of VOC contamination originally detected in MW2. The trip blank which was labeled MW11 contained Trichloroethene contamination. The presence of this compound within the trip blank indicates that the contamination was carried through the processing and analytical stages of the analysis. The contamination is most likely considered laboratory contamination.

The remainder of the VOCs that were collected are listed in Table 3.
The VOCs include compounds that are generally used as metal and plastic cleaners (1,1,1 trichloromethane) and refrigerant (dichloroethane) . The degreaser (bromodifluoromethane) was detected in the field blank (MW11). Since bromodifluoromethane was not detected in any other samples, the presence of this compound can be attributed to laboratory contamination.

TABLE 3: Additional Volatile Organic Compounds Detected

Well Location	Analyte Detected	Concentration (ug/l)
MW7	Dichlorodifluoromethane	130
MW1	1,1,1-Trichloromethane	1.1
MW3	1,1,1-Trichloromethane	0.34
MW10	1,1,1-Trichloromethane	0.34

ATEC Environmental Consultants
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Solid & Hazardous Waste Site Assessments
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Analytical Testing/Chemistry
Industrial Hygiene/Hazard Communication
Environmental Audits & Permitting
Exploratory Drilling & Monitoring Wells

August 1, 1990

Brundage Kroskin and Associates
4104 Granby Street
Norfolk, Virginia 23517

Attn: Mr. Irwin Kroskin

RE: Phase II Environmental Site Study
NAB Commissary Site
Virginia Beach, Virginia
ATEC Project Number: 26-08108

Dear Mr. Kroskin:

ATEC Environmental Consultants had appreciated the opportunity to conduct a Phase II Environmental Site Assessment of the NAB Commissary Site, located in Virginia Beach, Virginia. The purpose of this assessment is to satisfy the requirements of the client.

Enclosed is a report documenting all activities performed at the site, providing an interpretation of all generated data, and stating conclusions with regard to the overall environmental conditions at the site.

This assessment has been conducted in a manner to satisfy the client. If there are any questions, please contact this office.

Respectfully Submitted,

ATEC ENVIRONMENTAL CONSULTANTS

Lora B. Glover
Geologist

William S. Randall
Environmental Division Manager

3.0 ANALYTICAL RESULTS

The sampling program conducted for this project produced a discrete set of analytical chemical data which is included in Appendix C. The significance of each data set is discussed below. A parameter know as the Quantitation Detection Limit refers to the lower limit beyond which chemical components can no be detected by standard analytical procedures. While the limits for most parameters are quite sensitive, current analytical capabilities can not be warranted to detect chemical components below these levels.

The sampling and analysis program for this project was developed and implemented within the Quality Assurance/Quality Control (QA/QC) Standards established by ATEC Associates, Environmental Division. This plan is available upon request.

Soil samples that were collected during the well installation, were laboratory analyzed for Volatile Organic Compounds using EPA Method 624 and 625. Two contaminants (Methylene Chloride and Acetone) were detected but have been attributed to laboratory contamination. In sediment sample, SS-6, bis (2-Chloroethyl) Ether was detected in a concentration of 380 parts per billion. Sam Rottenburg, a toxicologist with the EPA, indicated that the presence of this contaminant without the detection of any other chloroether negates the validity of this result. Mr. Rottenburg stated that this location should be resampled to verify the initial results. All the remaining analyzed constituents were at or below the detection limit.

The water samples collected from the eight wells were analyzed for Priority Pollutants. Methylene Chloride and Acetone were also detected in several water samples and the field blank. The contaminants were attributed to laboratory contamination. Barium was detected in monitoring well 1 in a concentration of 0.08 mg/L which is below the Virginia State Water Control Boards established limit of 1.0 ppm. A table of the water results for volatile organic compounds detected is provided in Table 2.

TABLE 2 DRY CLEANING SOLVENT AND BYPRODUCTS

Well Locations	DRY CLEANING SOLVENT AND BYPRODUCTS (PPB)		
	Trans-1, 2-Dichloroethene	Trichloroethene	Tetrachloroethane
MW-2	460	370	670
MW-3	N/A	**	**
MW-4	N/A	14	20
MW-5	N/A	N/A	**
MW-6	N/A	**	**
MW-7	N/A	5	N/A
MW-10*	N/A	**	**
MW-12*	N/A	5	N/A

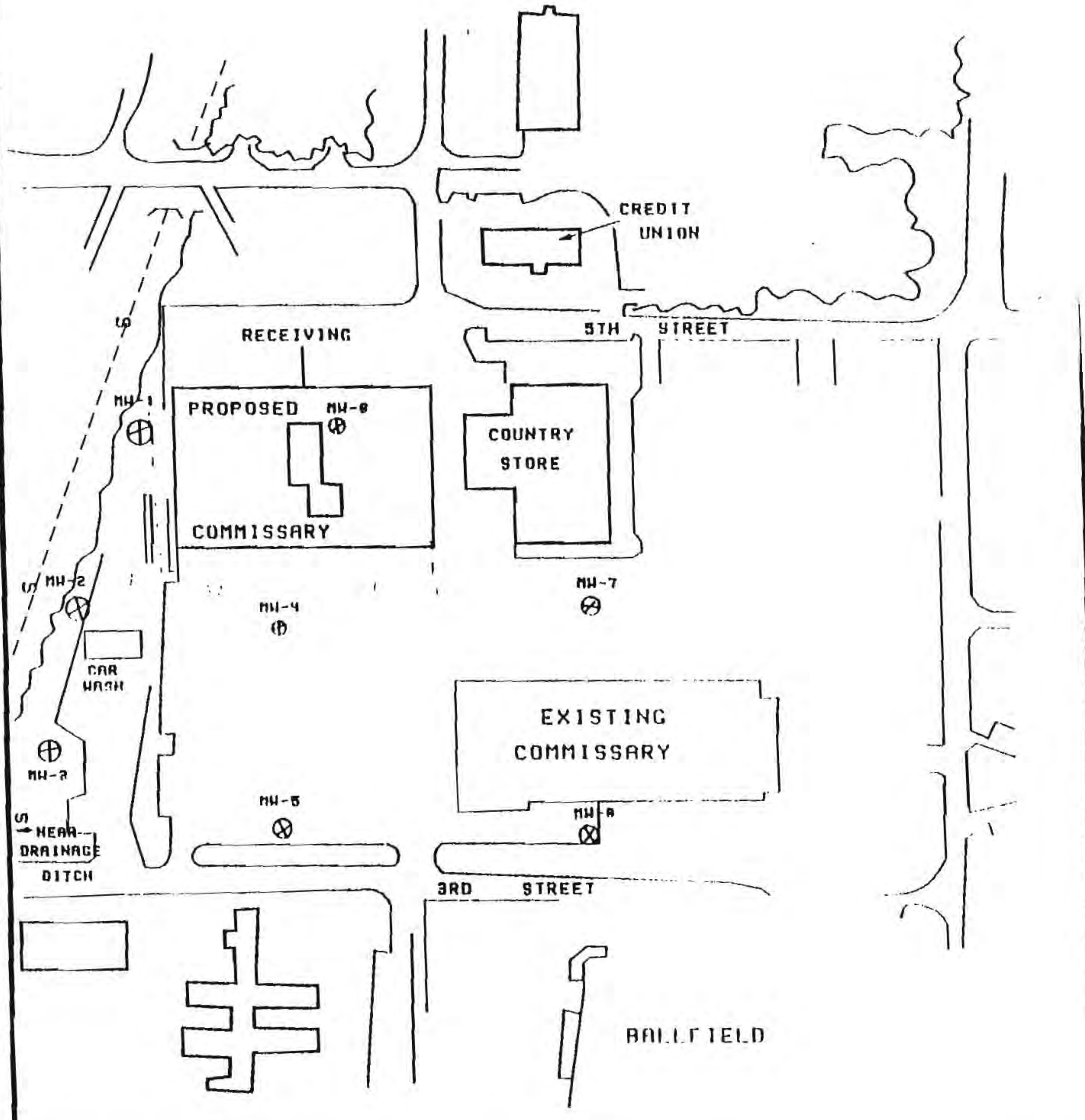
*-Duplicate Samples
**-Detected but in a concentration below the quantitation limit

These compounds are classified as hazardous waste according to the Chemical Substance Control Regulations published by the U.S. Bureau of National Affairs. The hazardous waste number for Trans-1, 2-dichloroethene is U 079, for tetrachloroethane U 210 and for trichloroethene U 228. Chemical abstract numbers include 156-60-5, 127-18-8, and 79-01-6 respectively.

Duplicate samples were collected from MW-1, 3, 5 and 7, and analyzed for volatile organic compounds and metals. The duplicate samples confirmed the finding of the monitoring wells as noted in table 2 since MW-10 is a duplicate sample of MW-3 and MW-12 is a duplicate sample of MW-7.

The laundromat has been abandoned since the early 1980's. Since no one witnessed any of the spills, it appears likely that the spills were episodic throughout the laundromat operation.

Additional samples were collected from monitoring wells 6 and 7, which were analyzed for Total Petroleum Hydrocarbons via EPA Method 8015. Samples were also collected from MW-1, 3 and 5, which were analyzed for HMX, RDX and TNT (compound generally present in explosives). The results of these groundwater samples revealed all the parameters to be below the detection limits.



ATEC ENVIRONMENTAL

SITE DESCRIPTION MAP

PROJECT: NAB COMMISSARY SITE

JOB NO: 26-08108

CLIENT: BRUNDAGE, KROSIN & ASSOC.

DATE: JULY 30, 1990

FIGURE 2

DRAWN BY: RFY

NOT TO SCALE

DRAFT

ENVIRONMENTAL ASSESSMENT REPORT

for

COMMISSARY CONSTRUCTION PROJECT

at the

NAVAL AMPHIBIOUS BASE LITTLE CREEK, VIRGINIA

NAVY CLEAN CONTRACT CTO 88

DECEMBER 1991

Prepared by:

Foster Wheeler Enviresponse, Inc.
100 E. Wilson Bridge Road
Worthington, OH 43085

DRAFT

ENVIRONMENTAL ASSESSMENT
for the
COMMISSARY CONSTRUCTION PROJECT
at the
NAVAL AMPHIBIOUS BASE, LITTLE CREEK, VIRGINIA

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EXECUTIVE SUMMARY

Baker/FWEI mobilized an Environmental Assessment Team to the Norfolk, Virginia, area on December 10 and 11, 1991. A document review was conducted on December 10 and a site visit at the subject construction site, the new Commissary at the Naval Amphibious Base in Little Creek, Virginia, was conducted on December 11.

It was determined that the environmental issues of concern are not presently being addressed as part of the scope of this construction project. Baker/FWEI makes several recommendations which are detailed in Section 3.0 - Recommendations of this report. Specifically, general construction at the site, especially activities requiring excavations below ground level, should cease. Baker/FWEI recommends that a Site Characterization on the construction site be performed. Based on environmental concerns defined from this characterization, it will also be necessary to develop a site-specific Health and Safety Plan (HASP), possibly a Remedial Design (RD) and a Waste Management Plan (WMP).

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ENVIRONMENTAL ASSESSMENT
for the
COMMISSARY CONSTRUCTION PROJECT
at the
LITTLE CREEK NAVAL FACILITY, VIRGINIA

1.0 INTRODUCTION

Baker Environmental/Foster Wheeler Enviresponse, Inc., Hereby referred to as the Team, through the NAVY CLEAN Contract, has been tasked by CTO 88 to perform a Remediation Assessment on the above-referenced project. A documents review and site walk were conducted by M. Finton, Project Manager; D. Locy, Hydrogeologist; and D. Workman, Construction Advisor from FWEI on December 10 and 11, 1991. This report describes the findings of this work effort, identifies environmental issues of concern and makes recommendations for resolution of these issues. As a result of a limited document review, additional suspect contamination, not directly related to a former dry cleaning operation named as the primary source of contamination on the site, was identified. During the site visit on December 11, 1991, the FWEI Team identified additional environmental items of concern not previously known or discussed in any documentation made available for review. These additional items include:

- The presence of two (2) underground storage tanks (USTS) which were removed on December 10 resulting in a spill incident.

- The presence of two (2) below ground concrete storage vaults containing an 18 inch layer of black sludge was discovered with a conveyor belt between the two vaults.

- It was also stated by on-site personnel that the buildings within the construction area, that had recently been demolished, were used for activities that typically created potential environmental hazards. These activities included a photographic laboratory, a metals plating operation, a power generation facility and an automobile hobby shop.

- It was also determined that more extensive intrusive excavations are planned than previously described.

Installation Restoration (IR) for the site must be addressed before further construction activity of the new facility makes restoration more difficult or infeasible.

(Draft 4, 12/16/91)

2.0 ISSUES OF CONCERN

2.1 Installation of Underground Utilities

Identified as the most immediate area of concern, the activities involving the installation of underground utilities and structures would have significant impact on the present status of this project. The suspect contaminate sources are mostly below ground surface, down to and including ground water. Intrusive activities including excavation of trenches exposes contaminated materials including soils, vapors from the soils in the vadose zone, and ground water. The environmental and regulatory impact of encountering and exposing these contaminated sources is the main issue of concern with this project.

Upon our review of the construction documents and the subsequent site walk, it was determined that the following intrusive construction activities were planned that would possibly expose contaminated sources:

- New Sanitary Sewer
- Grease Trap
- New Storm Sewer
- New Water Main
- Concrete Refrigeration Tunnel
- Loading Dock Foundation

There are several significant issues that exposure of contaminated soils and water create. These include:

- Regulatory Requirements
- Worker Safety (40 hour worker training required to work in a hazardous waste exposure area)
- Constructor Liability
- Liability to the Navy
- Disposition of Wastes Removed
- Alteration of Construction Methods

These issues will be discussed in subsequent sections of this report.

2.2. Isolation of the New Building from the Contaminated/Potentially Contaminated Environment

Should the decision be made to continue with construction prior to remediation, then the building should be isolated from the surrounding environment. At a minimum, an impermeable barrier of a High Density Polyethylene (HDPE) sheeting should be installed between the building, its support structures; any

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tunnels, appurtenances, or openings from or into the building and the supporting soils/ground water. Ideally, a minimum of a six inch layer of impermeable clay (1×10^{-7} cm/sec) would be placed between the HDPE sheeting and the contaminated soils/ground water. An appropriate sand layer between the clay and the HDPE liner should be considered to prevent punctures and tears during installation and future building construction/settlement. All openings, appurtenances or other avenues (interior support columns with footings/pads at or near soil/ground water interface, utilities conduit, piping, etc.) where volatile gasses could enter the building from below ground would need to be sealed (boots around piping, columns, ducting, etc. with non-shrinking grout or cement where possible).

2.3. Disposition of Contaminated Soil and Water

Soil and ground water sample and analysis results, conducted by Atec, Inc., from the subject area were discovered during the records review. The analytical results revealed contamination of spent solvents in the soils and ground water such as: TRICHLOROETHENE, TETRACHLOROETHENE, TRANS 1,2 - DICHLOROETHENE, VINYL CHLORIDE, CHLOROFORM, DICHLORODIFLUOROMETHANE, and METHYLENE CHLORIDE which are coded as Listed Hazardous Wastes (HW) and of an immediate concern. A sampling of the solids at several locations were conducted along one existing storm sewer system within the site construction boundaries. Closing the sewer systems in-place is not advised. The storm sewer should be removed and disposed of properly as supported by the analytical information. Sampling data provided from the confined area of this site is not sufficient to characterize all the soils for determining the extent of HW removal. It is recommended that further sampling and analysis be conducted to accomplish this characterization and that the storm sewer system in the southwest footprint of the building be sampled and considered for removal as HW. The monitoring well nearest one of the two storm sewer lines (MW2) has shown the highest contamination level of any well at the site. Our suspicion is that solvents from the former dry cleaning plant may also have been disposed of in this seemed storm sewer.

A WASTE MANAGEMENT PLAN (WMP) should be developed and exercised to assist in the management for the removal and disposal of hazardous wastes/contaminated ground water from the site. Backfilling of on-site soils is not recommended since it would be considered as landfilling (e.g. land disposal) as per the HW regulations.

2.4. Hydraulic Impact on the New Building from Future Remediation Activities

The foundation structure of the new commissary is designed to set on a floating foundation. [illegible]

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were ultimately required/selected to clean-up the ground water, it could impact the integrity of the foundation. A pump and treat ground water treatment system would require the installation of select extraction wells dependent upon plume direction and location. It is our opinion, that with all the factors taken into consideration, that these extraction wells, if installed, should not impact the foundation structure of the said building. We recommend that during any detailed site Remedial Investigation/Feasibility Studies (RI/FS) that the necessity for the installation of a recharge injection system be examined depending upon required drawdown rates, levels, etc., required for site remediation.

2.5. Requirements for Health and Safety and Environmental Oversight during Utilities Construction and other Intrusive Activities

On any hazardous or potentially hazardous waste site the health and safety of personnel is critical and also a requirement by OSHA (49CFR1910.120). To conduct any on-site activities, a HEALTH AND SAFETY PLAN (HASP) must to be developed addressing known and potential hazards. Environmental oversight should be considered for all intrusive construction activities to assure the compliance with the HASP, including the conducting of air monitoring during all intrusive aotivities on-site.

2.6. Regulatory Impact on Implementation of Possible Interim Remedial Action

Due to the current status of this project, it will be necessary to provide methods and means of resolution of the environmental issues as quickly as possible. The federal and state regulatory community must be informed of the proposed environmental elements that must be added to the project scope. It may not be necessary to obtain any permits in order to proceed with the project and the added environmental elements. It will be necessary to identify what the environmental elements are to the agencies, in a way, that these elements can be reviewed and understood by agency personnel. It will also be necessary to document what environmentally activities were performed during the project construction, that it was performed in accordance with regulatory requirements, and that no additional environmental problems were created from the execution of this project.

2.7. Impact of Site Remediation/Interim Measures on the Schedule for Construction

Possible impact on the construction schedule will follow one of three levels of impact as to degree depending upon the selection of any remediation/interim measures:

- Active Remediation

This represents the greatest impact on the construction since an

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environmental contractor must be brought in to address the environmental hazards and general construction would stop. Assuming an environmental contractor could be brought in under a task order/time and materials type contract, the actual removal of the various contaminated sewers and soils could be accomplished fairly quickly, probably less than sixty days. Ground water would require a somewhat longer time frame but installation of the various capture or venting systems probably could be done within this time frame (2 to 4 weeks).

- Passive Remediation

This constitutes a lesser interruption while at the same time addressing the minimum requirements both for construction to continue and to allow for future site remediation. This would be isolation of the building using an HDPE (high density polyethylene) barrier as outlined in concern #2 - Isolation of Building found above. It would also be possible to install some components of a passive venting system with only minor interaction with the general contractor. Impact would be 2 or 3 weeks.

Given the raw data from ATEC, it is probably unlikely that the various regulatory agencies will allow construction to proceed over the known contaminants. They may allow construction to proceed from the standpoint of adding some minimal engineering controls as described in this report.

- Delayed Remediation

This represents the minimum interference with the building construction. It assumes the contaminants can be addressed after the building is completed via some sort of ground water/soil washing process and that the regulators will concur that no engineering controls be installed. The probability of this passing the regulatory agencies is remote and not suggested as the minimal action level for this project.

The delay times reflected here with regards to increasing the time frame of the construction schedule are related to construction only. The time required to perform an additional or expanded site characterization and a remedial design is not included. A fast track site characterization will take at least 30 days with a remedial design taking 30 additional days. Procurement of services would add more days to the schedule.

2.8. Coordination between the General and Environmental Contractors

This would be determined by the Remediation Plan implemented at the site. If it is necessary to institute an active remediation effort then general construction would

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most likely stop. It is highly optimistic to think that there would not be migration of contamination if environmental and general construction occurs side by side. There is also the issue of protecting the general construction workers who would not have personal protective equipment and could be exposed to airborne releases of vapors from the environmental effort. Coordination of the contractors under this scenario would be next to impossible.

Should the Remediation Plan be more in the nature of passive remediation to be followed by remediation at a later date, then it would be possible to coordinate the two. This could be done via a task specific temporary stop work for the general contractor while the environmental contractor installs the HDPE barrier. It might even be possible for the general contractor to continue working by performing some tasks out of the proposed sequence. It might be of benefit to the general contractor to work out a rental arrangement with the environmental contractor as much of the equipment could be used for both types of work.

Delayed remediation would be performed upon completion of the proposed project was completed. This alternative, as discussed before, is not advisable due to regulatory and health and safety issues.

The environmental contractor could act as a subcontractor to the general contractor but this is not recommended due to possible conflict between the goals of the two types of work. It is probably best that the two efforts be independent.

2.9. Installation of Remedial Components Prior to General Construction

- This refers to construction of a passive venting, ducting system of gravel, perforated pipe in the gravel and a riser under and prior to installing the HDPE liner. It could also be designed and constructed to serve as a sparging/purging system in the ground water table. This could ultimately be completed into a venting, scrubbing arrangement at a later date. It would also serve as a drawdown/injection system below and throughout the building footprint to be activated following general site construction. It could be a hybrid of all three or even a more exotic design.

2.10. Identification of Remedial Alternatives (as Interim Remedial Measures)

There are several environmental actions in terms of addressing and resolving the environmental issues of concern on this project. The remedial alternatives we have identified include the following:

- Excavate all contaminated soils and storm sewers prior to construction of the new building.
- Install a Vacuum Extraction System.

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(Draft 4, 12/16/91)

- Install a Ground Water Extraction System.
- Mobilize a Carbon Filtration and/or Air Stripping Treatment Units for pretreatment of contaminated ground water.
- Install a plastic HDPE barrier between the building and the contaminated environment.

2.11. Demolition of Existing Buildings

Due to the fact that there are contaminating sources known to be present in these areas, it is possible that the building foundations and slabs may have provided a conduit for contaminants to collect under these structures. An environmental assessment, of the previous areas where the buildings were located, would be prudent. Initial assessments using field instrumentation for measuring organic volatiles with additional sampling and analysis of soils within the footprint of the old structures as a way of hopefully releasing these areas for future concern prior to new construction in these same areas.

2.12 Additional Site Contamination Concerns

While conducting our site visit, both activity and contractor personnel highlighted recently discovered potential contamination from former buildings, industrial operations and underground storage tanks. Along with the additional sampling and analysis recommended for the dry cleaning waste disposal areas, a site characterization for these areas is suggested. One area appears to contain oily sludge from a former power plant and other former buildings present the potential for additional heavy metal and organic analysis for HW characteristics prior to removal and disposal.

3.0 RECOMMENDATIONS

The construction of the new Commissary at the Naval Amphibious Base, Little Creek, Virginia, is presently scoped or specified with little or no consideration to environmental issues. To proceed with this project as presently scoped will create further complications to environmental issues that are known to exist at this site. Baker/FWEI, based on the Environmental Assessment of this project makes the following recommendations:

1. A site characterization to further delineate the environmental issues of concern should be conducted prior to any additional intrusive activities in the construction area.

2. A site-specific Health and Safety Plan (HASP) must be developed for the site characterization as well as all on-site construction.

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(Draft 4, 12/16/91)

3. A Waste Management Plan (WMP) must be developed for all wastes identified to be present as a result of the site characterization.

4. A Remedial Design (RD) is recommended which will be developed, as determined appropriate and to comply with federal and state regulations, following the results of the site characterization.

5. An environmental contractor will be required in order to implement the RD either as a subcontractor to the current contractor or by a separate procurement.

6. A report of the remedial actions taken in order to proceed with the project must be written to be able to demonstrate that the new building has been constructed in a manner that does not adversely effect the environment.

MAY 20 1991

MEMORANDUM

From: Code 1822
To: Code 09A21

Subj: PHASE II ENVIRONMENTAL SITE STUDY, COMMISSARY SITE, NAVPHIBASE LITTLE CREEK

Ref: (a) PHONCON Code 09A21 (Ms. D. L. Riddle)/Code 1822 (Mr. A. R. Kissell) of 13 May 91

1. As discussed in reference (a), any water pumped during construction of the subject project will have to be containerized and analyzed for TCE, vinyl chloride, etc., prior to disposal. MCON project P-184 at NAS Oceana has a similar stipulation.

2. Adequate protection should be afforded workers exposed to groundwater from the site. Recommend the A/E include a specification section to cover this concern.

3. The Virginia Department of Waste Management is aware of this site.

4. During the scoping/negotiation meeting of 26 February 1991 held at Code 18, ATEC agreed to properly label drums for well development water. The drums have been moved to a central location, but no labels or markings exist to match drums to wells. Request project management instruct the A&E of record to sample, analyze, and label the drums, so that NAVPHIBASE Little Creek may process them for disposal.

5. The subject report has numerous errors which need to be corrected. More detailed comments on this report will be provided within four weeks.

6. POC is Mr. Scott Park at 5-4803.

A. R. KISSELL, P.E.
Head
Installation Restoration Section
Environmental Programs Branch
Environmental Quality Division

Copy to:
408
1822 (SRP)
18S
Doc: 415-srw

(804) 445-6911

5090
1822:JPW

16 DEC 1991

Virginia Water Control Board
Tidewater Regional Office
Attn: Mr. Bob Goode
287 Pembroke Office Park
Suite 310, Pembroke No. 2
Virginia Beach, VA 23462-2955

Dear Mr. Goode:

We request permitting guidance from the Board concerning a potential point source discharge of groundwater resulting from the construction of a new Commissary at Naval Amphibious Base (NAVPHIBASE) Little Creek. Construction of the Commissary is being impacted until the issues concerning the disposal of construction site dewatering are addressed.

It was determined that groundwater at the site is contaminated based on a site investigation of the construction area. Data from monitoring wells at and around the construction site indicates contamination of the groundwater with several types of solvents that may have been used at a former dry cleaning plant at the site. This monitoring well data and site location maps are enclosed for your information.

Site dewatering is required for construction of both interior and exterior utilities for the Commissary. Reasonable steps will be taken during construction to minimize the amount of dewatering required, including investigating the modification/relocation of storm and sanitary sewer lines to higher elevations. We propose to treat the contaminated groundwater on-site with a trailer mounted air stripper system and discharge the effluent to a nearby stormwater outfall. The current construction schedule estimates requiring no more than 45 days of dewatering with an estimated total maximum volume of 150,000 gallons to be discharged (estimate 5000 gpd as the average flow rate).

Even though construction dewatering is noramally exempt from VPDES permitting, we request you respond in writing whether or not a modification to the NAVPHIBASE Little Creek VPDES permit is required to commence discharge of this construction site dewatering. As the contract has been awarded and the contractor is ready to proceed with site utilities, your earliest response is requested and appreciated.

5090
1822:JPW

Please contact me or Ms. Christine Wallace at (804) 445-6982 for any questions you may have concerning this matter.

Sincerely,

P. A. RAKOWSKI, P.E.
Head
Environmental Programs Branch
Environmental Quality Division
By direction of the Commander

Encl:
Site Vicinity and Monitoring Well Maps & Groundwater Data

Copy to: (w/encl)
NAVPHIBASE Little Creek
ROICC Little Creek

Blind copy to: (w/o encl)
09A
09A2
04
05
18
181
1812 (CHW w/encl)
182
1822 (JPW)
18S
LANTDIV Reading File
JPWDOC:XXCOMLTR.JPW

EXTENT OF SUBSURFACE FUEL CONTAMINATION

LITTLE CREEK NAVAL AMPHIBIOUS BASE

For

Atlantic Division
Naval Facilities Engineering Command

Contract N62470-82-B-7800

By

R. E. Wright Associates, Inc.
3240 Sch lhouse Road
Middlet PA 17057

October, 1982

Respectfully submitted,

Robert C. Brod
Project Manager

Ned E. Wehler, PG
Vice President

AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS
CERTIFICATE NUMBER
4251
AIPG
NED E. WEHLER

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APPENDICES

FUEL FACILITY LEAKAGE STUDY
AT THE NAVAL AMPHIBIOUS BASE,
LITTLE CREEK, VIRGINIA

Contract N62470-82-B-7800

INTRODUCTION

This report describes a hydrogeologic investigation which was conducted to delineate the extent of subsurface fuel contamination at the Little Creek Naval Amphibious Base, and to recommend appropriate response procedures. As stated in a scope of work prepared by LANTDIV, the program objectives were as follows:

> Test and study the geology and hydrology along the water front and around bulk storage facilities at the Naval Amphibious Base, Little Creek, to determine the extent and severity of petroleum leakage and land based spills, the sources of the same, and the best practical methods of abatement and cleanup. The final objective is the determination and the development of corrective projects.

The investigation was initiated in part as a result of the known subsurface occurrence of fuel in the vicinity of Piers 11-19 at the base. The extent and threat posed by this fuel has not been known, however. Thus, it was desired to determine the following things about the area near Piers 11-19:

* If and where fuel does occur in the subsurface.

* Whether it is mobile or potentially mobile.

* What likelihood there is that it could enter ship wastewater lines and in turn damage the effective operation of the Hampton Roads sewage treatment plant.

* Whether the presence of fuel poses any other significant environmental threat.

* What remedial actions are appropriate.

Prior to this investigation there had been no knowledge of the occurrence of subsurface fuel at other fuel facilities at the base. However, the investigation was designed to include subsurface exploration at the other fuel facilities where there is some potential for substantial fuel leakage. Thus, in addition to the Pier 11-19 area, investigations were performed at the Steam Plant, the Fuel Farm (11th Street and Desert Point Road), and Tank 1551 (west of Piers 11-19). The locations of these sites are shown in Figure 1.

The approach of this study has been to acquire as much existing information as possible regarding subsurface conditions at each of these sites. Based on this, field investigations were conducted to gather more definitive information. The results of these investigations were then evaluated in order to characterize the conditions at each of the sites. In light of the results, possible remedial actions were evaluated for those areas where substantial subsurface fuel does occur.

The following section of this report will describe in more detail the methods of investigation that were employed at each of the four sites. Subsequent sections will describe the following for each site at the base:

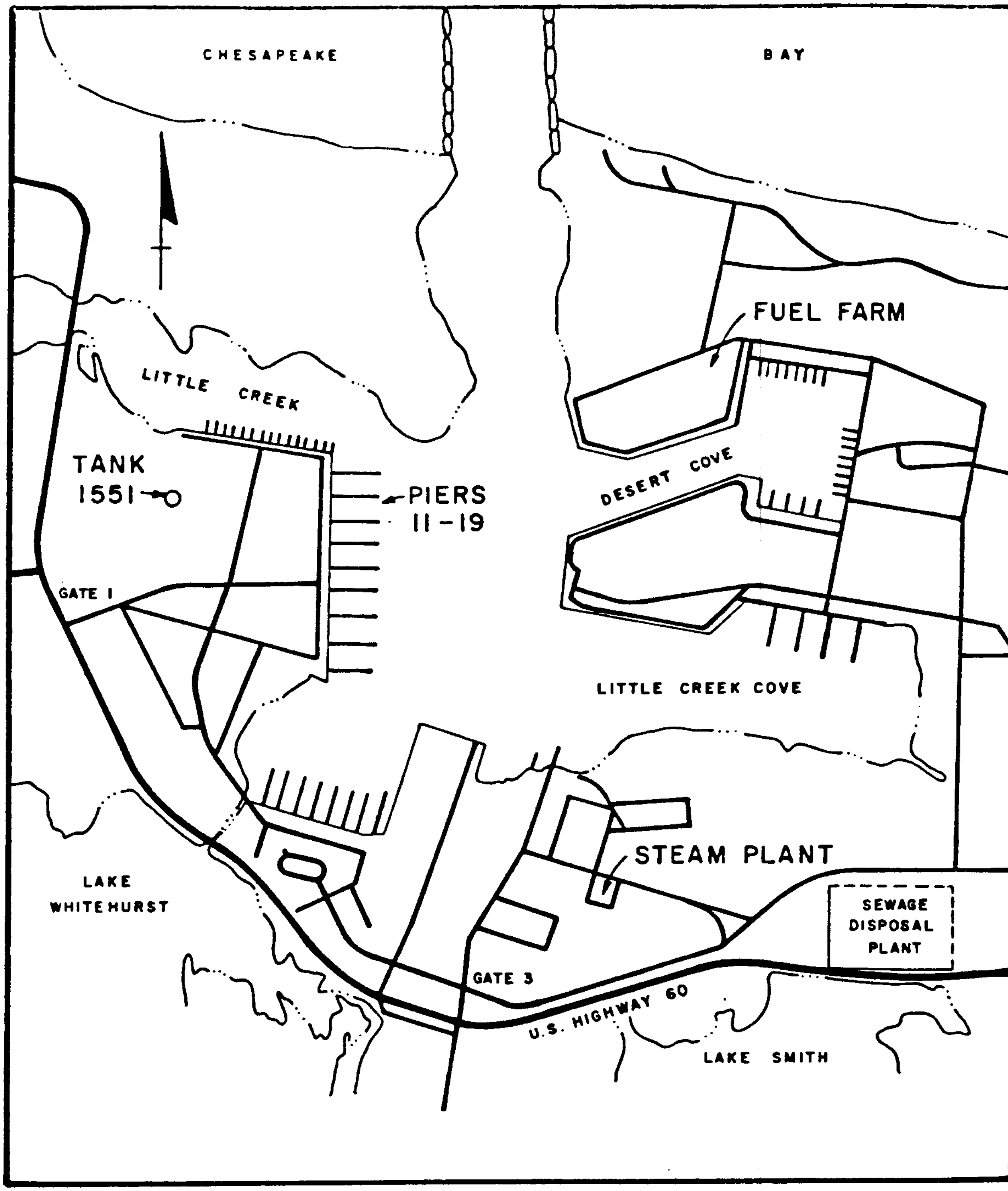


Figure 1: Locations of Fuel Farm, Steam Plant, Tank 1551, and Piers 11-19 at the Little Creek Naval Amphibious Base.

* The history of pertinent operations and known fuel leaks.

* Methods of investigation that were unique to each site.

* Results of the subsurface investigation.

* How much fuel occurs in the subsurface, how mobile it is, and what type of threat it poses.

* What remedial action is warranted.

METHODS OF SUBSURFACE INVESTIGATION

Based on prior knowledge of site conditions, backhoe pits, test borings, and monitoring wells were installed at selected points at the four sites. These facilitated the direct observation of subsurface conditions and provided the means by which to measure and sample.

Backhoe Pits

Backhoe pits are simple excavations that are typically about 10 feet long, 4 feet wide, and as deep as subsurface or machine limitations permit. They are a rapid, inexpensive means to determine subsurface conditions; results from them were used in the early part of the investigation to guide the location of test borings and monitoring wells. Additionally, they permitted the description of some subsurface conditions that cannot be determined with test borings and monitoring wells. These typically included the nature of layer interfaces, soil structure, and perched groundwater conditions.

In this investigation 11 backhoe pits were dug at the four sites based on the anticipated location of potentially occurring subsurface fuel; their locations were also based on the position of fuel facilities and the anticipated direction of groundwater movement. Subsurface conditions were described from the visual observation of pit walls, grab samples, and groundwater. Descriptive logs from each backhoe pit are included in Appendix A.

In those pits where groundwater was reached and where the pit walls were competent, standpipes were installed prior to backfilling. In all, six standpipes were installed, all in the vicinity of Tank 1551 and Piers 11-19. The standpipes consisted of four-inch seepage bed pipe which was constructed of thin-wall perforated PVC. Each was capped at the bottom and wrapped with burlap in an attempt to prevent an excessive influx of sediment through the perforations. The standpipes were placed vertically in the open backhoe pits; the pits were then backfilled to the surface.

Test Borings and Monitoring Wells

In this investigation it is assumed that test borings are drilled holes where sediment samples have been taken; monitoring wells are the small diameter well screens and casings (pipes) that are placed in the borings which permit sampling and measurements to be made of subsurface fluids. Monitoring wells were installed in all of the test borings made during this investigation. Logged data from previous test borings was also used to characterize subsurface conditions.

Test borings and monitoring wells were located based on the results of the backhoe pit investigations, on the anticipated occurrence of subsurface fuel, and on the locations of underground utilities. The borings were advanced to a depth of 20 feet with hollow-stem augers and continuous split-spoon sampling. All split-spoon samples were described immediately after recovery in terms of sediment characteristics, moisture content, and degree of fuel odor. Test boring logs are presented in Appendix B.

A schematic monitoring well design is illustrated in Figure 2. In the initial part of the well construction, after the hollow-stem augers were removed from the borehole, a 4-inch diameter pipe was inserted to keep the hole open. Each boring was then backfilled with well-sorted coarse sand to a depth that permitted the well to be screened above and below mean tidal level. A 10-foot long by 2-inch diameter section of well screen was then installed in the borehole and backfilled with well-sorted sand.

During the backfilling process the 4-inch casing was removed gradually to prevent the collapse of natural sediments onto the well screen. Approximately one foot of well-sorted sand was placed above the top of the screen. A bentonite seal was then installed and the remainder of the hole was backfilled. Those monitoring wells installed beneath pavement at Piers 11-19 were covered with 6-inch manholes which are flush to the pavement and concreted in. At other monitoring wells the casing sticks up 1-2 feet above the ground surface.

Each monitoring well was developed to verify and enhance the hydraulic connection between the well and the natural sediment. This was done by periodically pumping each well for a period of one hour.

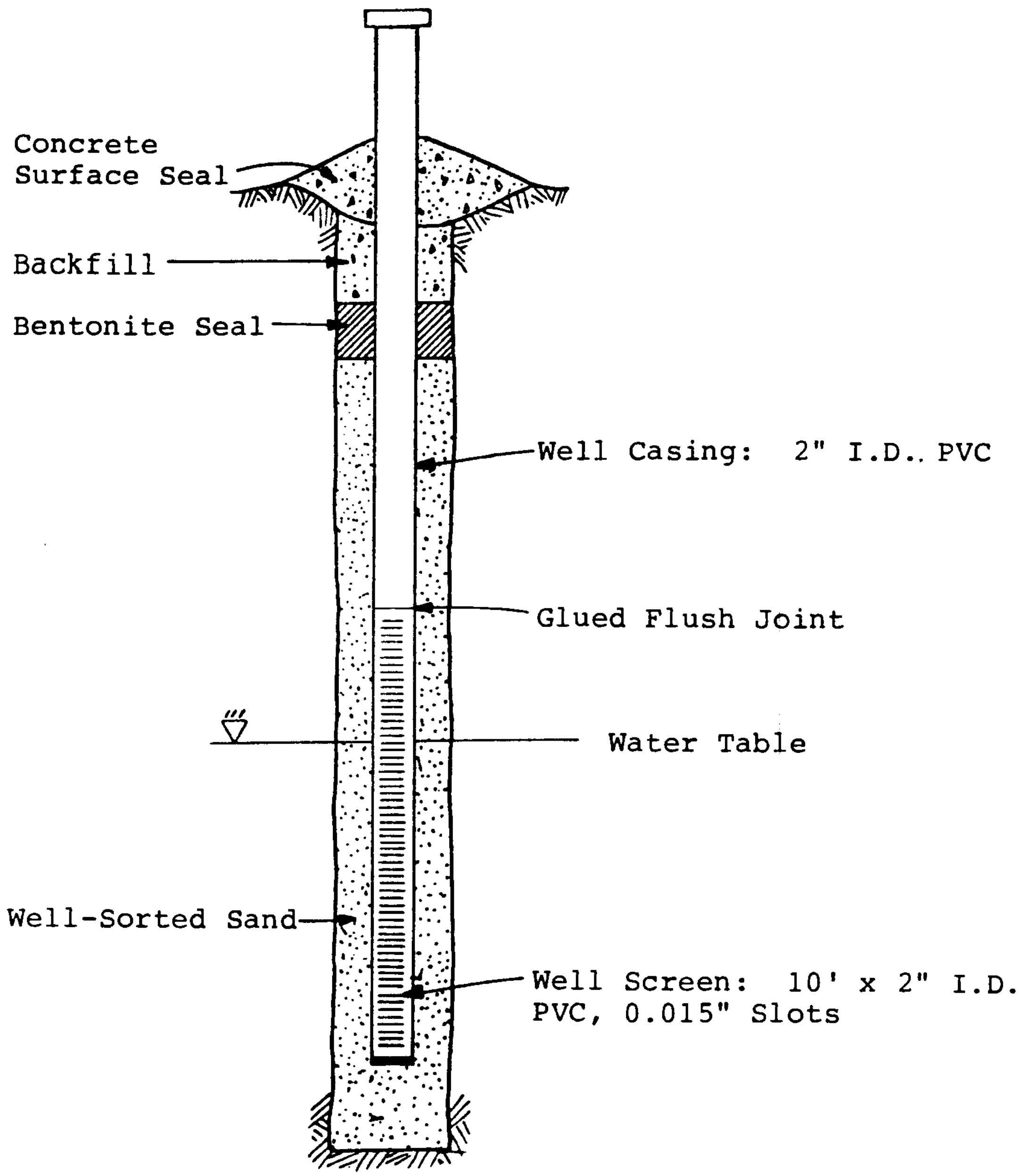


Figure 2: Schematic Monitoring Well Design

Monitoring Well Testing

The occurrence of fuel in backhoe-pit sediments and split-spoon samples was checked visually and by smelling the samples. Generally, odor is a more reliable qualitative indicator since small amounts of fuel in soil tend to appear like water. Sediment containing small amounts of fuel commonly cannot be visually distinguished from those containing water. Five split-spoon samples were analyzed quantitatively for fuel concentration by a local laboratory. These will be discussed further in a subsequent part of this report.

The occurrence of free-floating fuel on the water table was determined with a transparent bailer and with fuel and water-sensitive paste. The paste changes color in response to the occurrence of water and fuel, permitting the measurement of fuel thickness in the well.

Water-table depths were measured with a wire recorder and with water-sensitive paste. The elevation of the top of each well casing was surveyed (Appendix C) to permit the standardization of water-table levels.

STEAM PLANT

History of Fuel Leakage

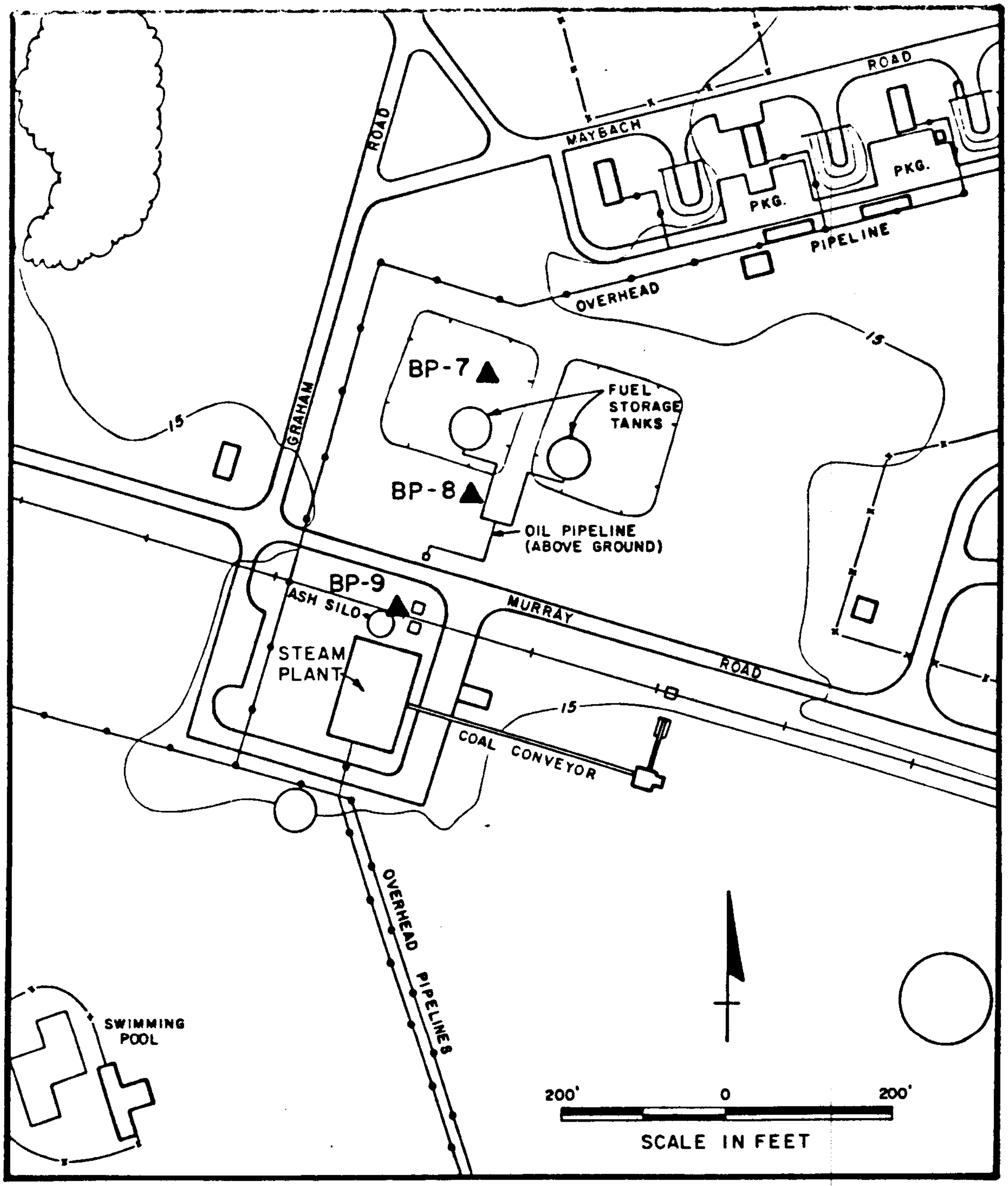
Discussions were held with Steam Plant personnel and with Mr. Mac Staples, Fuel Supervisor. These individuals had no knowledge of any subsurface occurrence of fuel at the Steam Plant, or of fuel leaks or spills which might have resulted in subsurface contamination.

Subsurface Investigation

In order to determine the presence of subsurface fuel at the Steam Plant, three backhoe pits were dug there. Locations of these pits are shown in Figure 3. Descriptive logs from the pits are shown in Appendix A.

Backhoe Pit BP-7 was located north of the western fuel-storage tank, across Murray Road from the plant. The excavation indicated a clayey-silt layer near the surface, which was underlain by about 5 feet of well sorted sand fill. The sand fill was underlain by poorly sorted naturally occurring sand. No standpipe was installed in the excavation due to severe wall collapsing and the location of the pit in the fuel-storage tank berm. No fuel was observed in the sediments from BP-7, nor in groundwater that accumulated in the excavation.

Backhoe Pit BP-8 was located in the unpaved parking lot across Murray Road from the Steam Plant (Figure 3). It exhibited 4 feet of sand near the surface, which was underlain by a stratigraphic sequence similar to that observed from the surface down in BP-7. No standpipe was installed in BP-8 due to wall collapsing. No fuel was observed in BP-8.



▲ Backhoe Pit

Figure 3: Steam Plant area, showing locations of backhoe pits.

Backhoe Pit BP-9 was located next to the Ash Silo immediately in front of the Steam Plant. It indicated the occurrence of 5 feet of fill which was underlain by naturally occurring silty sand. The natural sediments had a sharp hydrogen sulfide smell. No standpipe was installed in the excavation due to collapsing conditions and the location of the pit in a work area. No fuel was observed in BP-9.

Summary and Recommendation

Three backhoe pits were excavated at the Steam Plant in an attempt to determine whether spilled or leaked fuel occurs in the subsurface. No fuel was observed in any of the pits.

It is concluded that significant amounts of fuel do not occur in the subsurface at the Steam Plant; therefore, no further action is warranted at this time.

FUEL FARM

History of Fuel Leakage

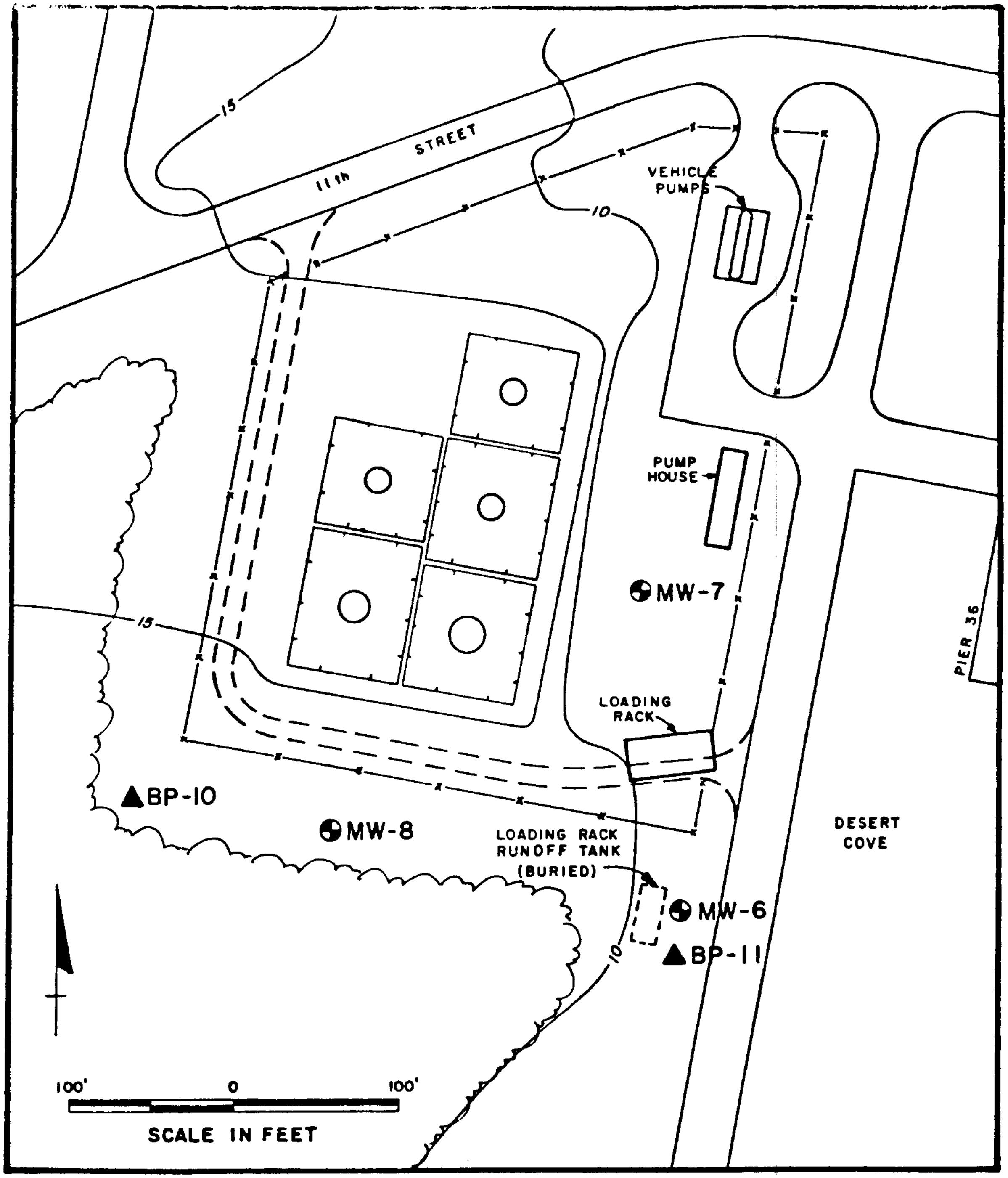
Fuel Farm personnel, particularly Mr. Mac Staples, were interviewed and had no knowledge of the subsurface occurrence of fuel at the Steam Plant, or of fuel leaks or spills which may have resulted in subsurface contamination.

It was reported that small amounts of fuel are occasionally spilled at the loading rack which is at the southeastern corner of the facility, and also at the vehicle pump area which is in the northeastern corner. In the former case, runoff and any spilled fuel drains into a nearby buried tank (Figure 4). Runoff from the vehicle pump area drains directly into Desert Cove. The integrity of these surface-spill drains was beyond the scope of this project and was not investigated.

Subsurface Investigation

Two backhoe pits were dug at the Fuel Farm, as shown in Figure 4. Descriptive logs from the pits are presented in Appendix A.

Backhoe Pit BP-10 was located outside of the fence at the southwestern corner of the site. Sediment in it consisted primarily of dune sand; the upper three feet was fill comprised of well-sorted sand and miscellaneous organic debris. Although a small influx of perched groundwater occurred at a depth of about 5 feet, the water table was not encountered at the pit's total depth of 7.5 feet. Because of this and collapsing walls, no



▲ Backhoe Pit

⊕ Monitoring Well

<u>Figure 4</u>: Fuel Farm area, showing locations of backhoe pits and monitoring wells.

standpipe was installed in the pit. No fuel was observed in the sediments from BP-10.

Backhoe Pit BP-11 was located approximately 15 feet southwest of the buried tank that collects runoff from the loading rack (Figure 4). Sand fill occurred to the pit's total depth of 8 feet. Collapsing walls prevented digging to the water table; as a result, no standpipe was installed. No fuel was observed in the sediments from BP-11.

Three monitoring wells were installed at the Fuel Farm in order to determine conditions at the water table (below the reach of the backhoe) and within the relatively confined fenced-in area (Figure 4). Geologic logs and construction specifications for each well are shown in Appendix B.

Monitoring Well MW-6 is located about 10 feet east of the buried tank near the loading rack (Figure 4). Stratigraphy in the upper 10 feet was essentially the same as that observed in BP-11. Naturally occurring sand and silt was found below 10 feet. No fuel was observed in split-spoon samples or on the water surface in the completed well.

Monitoring Well MW-7 is located near above-ground tanks in the yard southwest of the Pump House. Sediment in it consisted largely of fine to coarse loose sand; thin silty and clayey seams occurred below the water table. No fuel was observed in split-spoon samples or on the water surface in the completed well.

Monitoring Well MW-8 is located inside of the fence along the southern side of the site. Sediment in it consisted of fine to coarse sand with silty and clayey seams occurring below 6 feet.

No fuel was observed in split-spoon samples or on the water surface in the completed well.

Summary and Recommendations

Two backhoe pits were excavated and three monitoring wells were installed at the Fuel Farm in an attempt to determine whether fuel occurs in the subsurface. No fuel was observed.

It is concluded that significant amounts of fuel do not occur in the subsurface at the Fuel Farm; therefore, no further action is warranted at this time.

TANK 1551

Tank 1551 is a half million gallon half-buried tank used to store ship fuel for use at Piers 11 through 19. It is located about 1500 feet west of the piers (Figure 1).

History of Fuel Leakage

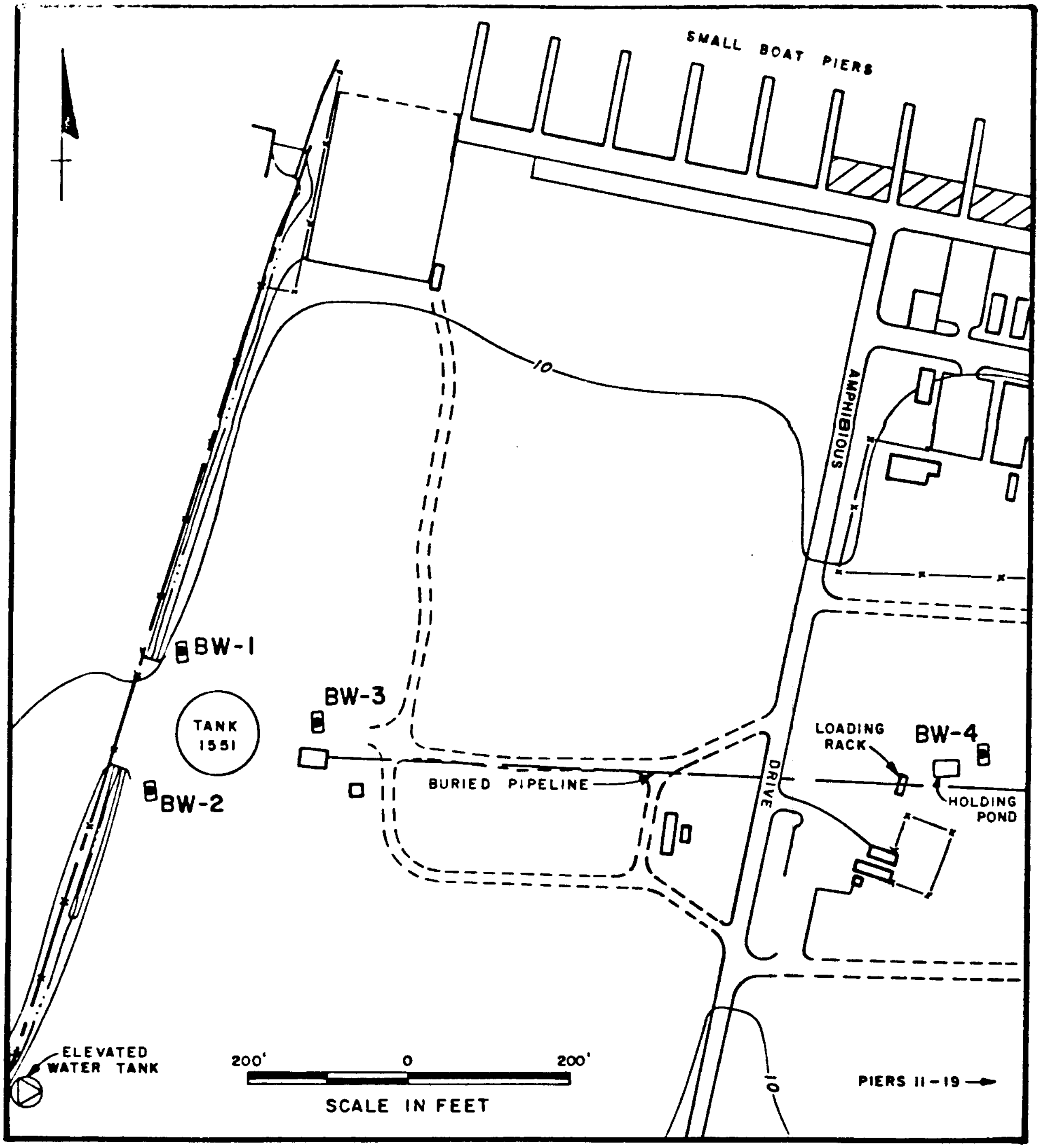
Fuel facilities personnel were interviewed and indicated no knowledge of leakage or the subsurface occurrence of fuel near Tank 1551.

Subsurface Investigation

Three backhoe pits were dug near Tank 1551, as shown in Figure 5. Descriptive logs from the pits are presented in Appendix A.

Backhoe Pit BW-1 was located approximately 30 feet north of the buried tank. In it well-sorted sand fill occurred to the pit's total depth of about 8 feet. Groundwater entered the pit at a depth of about 7 feet. However, no fuel was observed in the groundwater or in sediment from the pit.

A standpipe was installed in BW-1 to permit subsequent groundwater monitoring. Standpipe construction materials and methods of installation are described in the Methods section of this report. Samples from the standpipe confirmed that no fuel has accumulated on the water table in the vicinity of BW-1.



Backhoe Pit with Standpipe

Figure 5: Tank 1551 area, showing locations of backhoe pits and standpipes.

Backhoe Pit BW-2 was located about 25 feet southwest of Tank 1551 (Figure 5). Sand fill occurred in it to a depth of about 5 feet, and was underlain by silty sand. No fuel was observed in the sediments or in groundwater that accumulated in the bottom of the pit. Samples from a standpipe in BW-2 confirmed that no fuel has accumulated on the water table in the vicinity of the pit.

Backhoe Pit BW-3 was located about 20 feet north of the Pump House at Tank 1551 (Figure 5). Fill occurred down to the pit's total depth of 11 feet, and it was primarily sand. Silty clay layers occurred at about 5 feet and 6 feet (Appendix A). A minor perched groundwater system was caused by the upper silty clay zone. No fuel was observed in sediments from the pit or in groundwater which accumulated in the pit.

Two standpipes were installed in BW-3. A deep one (length of 11 feet) was placed in order to sample groundwater from both the main groundwater system and the minor perched system. The shallow standpipe was installed to a depth of 4 feet in order to sample just the perched system. Observations in both standpipes confirmed that no fuel is present in the subsurface in the vicinity of BW-3.

Summary and Recommendations

Three backhoe pits were excavated near Tank 1551 in an attempt to determine whether fuel occurs in the subsurface. Prior to backfilling, standpipes were placed in each pit to facilitate groundwater monitoring. No fuel was observed in backhoe-pit sediments, in groundwater which accumulated in the pits, or in groundwater in the standpipes.

It is concluded that significant amounts of fuel do not occur in the subsurface in the vicinity of Tank 1551. On this basis, monitoring wells were deemed unnecessary. No further action is warranted at Tank 1551 at this time.

PIERS 11 - 19

The area of investigation at Piers 11 to 19 is generally beneath the long pavement and parking area which is adjacent to all the piers. The area is approximately 2000 feet long and 250 feet wide. Also discussed in this section are the results from a single backhoe pit excavated near the subsurface fuel pipeline that connects the Pier area to Tank 1551.

History of Fuel Leakage

The following information was obtained from Mr. Staples, Fuels Supervisor, and Mr. Seay of the Transportation Department.

In the 1950's, prior to the paving of the parking lot, waste oil was periodically dumped or sprayed onto the area for dust and runoff control. Several thousand gallons of this reportedly came from small tanks at Quonset huts when the huts were abandoned.

In the 1960's, approximately 11,000 gallons of ship fuel was lost from the subsurface pipeline in the vicinity of Piers 16 to 19. This loss is thought to have been in the form of a number of slow leaks in the pipe, probably resulting from electrolysis. Leakage was enhanced by line pressures of 60 to 80 psi during fuel loading and unloading. A new fuel pipeline was installed in 1970.

Concern about the subsurface occurrence of fuel at the piers began in the mid 1970's when the ship wastewater sewer was installed. During the installation, several hundred thousand gallons of groundwater and fuel were pumped from excavations. However, only a small fraction of this was fuel. Since the installation of the sewer system, small amounts of water and fuel have been pumped from transfer pits, sumps, and manholes about once a month.

Fuel was observed in the new sewer soon after it was built. It is thought that seepage into the sewer line resulted from the decomposition of gaskets at pipe joints, caused by the fuel. Two or three test borings were drilled about a year after the sewer was installed in an effort to delineate the extent of subsurface fuel at the northern end of the piers. The results of these borings were inconclusive.

There has been continuing uncertainty about the extent and mobility of subsurface fuel in the pier area. Of particular cause for concern has been the possibility that relatively large amounts of fuel could become mobilized, enter the sewer line and eventually enter the treatment system at the nearby Hampton Roads Sewage Disposal Plant. This could cause serious problems with the normal operation of the plant, resulting in large costs to the Navy. It was this possibility that was largely responsible for the initiation of this study.

Subsurface Investigation

Three backhoe pits, four standpipes, and six test borings and monitoring wells were used to determine subsurface conditions in the vicinity of Piers 11 to 19. The locations of these are shown in Figure 6.

Backhoe Pits and Standpipes

Backhoe Pit BW-4 was excavated near a catch basin which holds runoff from the loading area between the piers and Tank 1551 (Figure 6). It is also located near the underground pipeline which connects Tank 1551 to the pier area. Although this

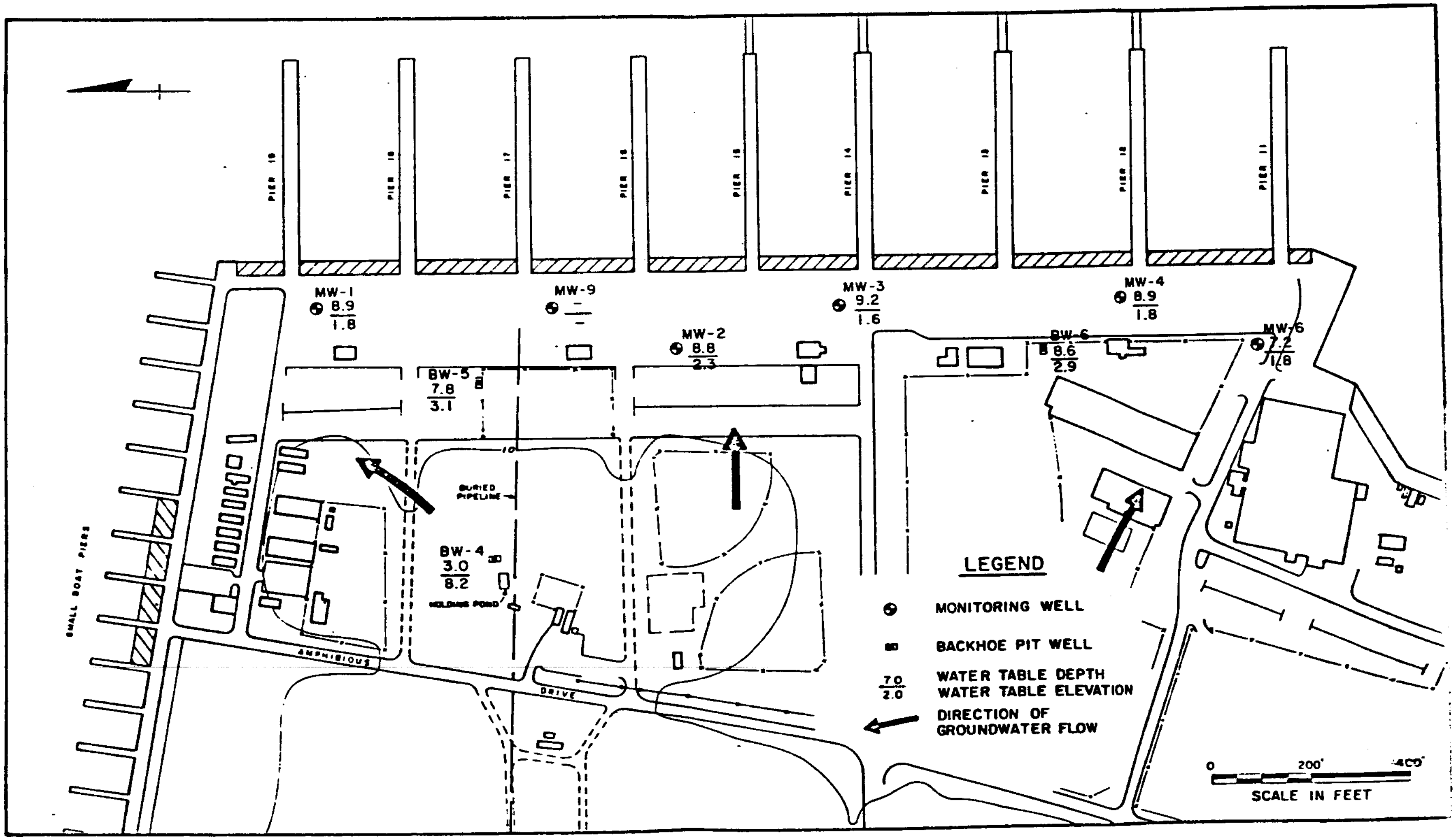


Figure 6: Pier 11-19 area, showing locations of monitoring points and water-table levels. Arrows show directions of groundwater flow.

location is not part of the pier area where subsurface fuel is known to occur, it is described here because of its general proximity to the piers.

In BW-4, fill consisting of sand and pockets of silt occurred to a depth of approximately 5 feet (Appendix A). This contained a minor perched groundwater system caused by the silt pockets. Sediment from this interval seemed to have a slight fuel odor; however, a strong odor from oil in a nearby catch basin made the determination of this uncertain. The fill was underlain by naturally occurring silty sand. Groundwater in the bottom of the pit had a trace of oil sheen on its surface.

Two standpipes were installed in BW-4. As in BW-3, a deep one was placed to sample groundwater from the main groundwater system as well as the minor perched system. A shallow one was installed in order to sample the perched system only. Subsequent observations indicated that a very slight oily sheen occurred on the water surface in the deeper standpipe. A slight fuel odor was also apparent in the deeper standpipe. However, there was not a measurable thickness of free floating fuel in the deeper standpipe. No fuel was apparent in the shallow standpipe.

Therefore, it is evident that very small amounts of fuel are floating on the main water table in the vicinity of BW-4. It seems likely that it has originated from the nearby catch basin, which contains water and fuel runoff from the loading facility. A leak in the pipeline between the piers and Tank 1551 would probably have resulted in larger amounts of fuel floating on the water table.

Two backhoe pits were excavated just west of the paved parking lot that extends from Pier 11 to Pier 19. BW-5 was between Piers 17 and 18, near the pipeline that goes from the piers to

Tank 1551 (Figure 6). In it, sand and silt fill extended to a depth of 7 feet, and was underlain by naturally occurring well sorted sand. A distinct fuel odor was observed in the saturated, naturally-occurring sediments below 7 feet. A standpipe installed in BW-5 had a moderately distinct fuel odor in it, but no measurable free floating fuel. Backhoe Pit BW-6 was excavated just west of the pavement opposite Pier 13 (Figure 6). In it, sand and silt fill occurred to a depth of about 6 feet, and was underlain by naturally-occurring sand. No fuel was observed in the fill; however, a distinct fuel odor was observed in saturated sediments below 7 feet. A standpipe in BW-6 had a slight fuel odor in it.

Test Borings and Monitoring Wells

In order to determine subsurface conditions beneath the pavement, six test borings and monitoring wells were installed in the pier area. Locations are shown in Figure 6. Installation procedures are described in the Methods section of this report. Geologic logs and construction details for each well are shown in Appendix B.

Monitoring Well MW-1 was installed near Pier 19. Split-spoon sampling indicated that sand fill occurred to a depth of about 7 feet, and was underlain by sand and some layers of silty sand. Slight fuel odor was observed in all sediments above the water table, and a strong fuel odor was observed in sediments at and below the water table.

Samples from below the water table would not normally be expected to contain free (undissolved) fuel. Fuel which was observed in samples from beneath the water table probably originated in groundwater at the water table, and contaminated the sampler as it passed through that interval.

Monitoring Well MW-2 was augered in the parking area between Piers 15 and 16. In it, sand fill occurred to a depth of about 5 feet, and was underlain by silty sand and layers of clay and peat. No fuel was observed in sediments down to 6 feet. A slight fuel odor was observed in sediments just above the water table and in saturated sediments at the water table.

Monitoring Well MW-3 is located in the parking area opposite Pier 14. Sand fill extended to a depth of about 6 feet and was underlain by naturally occurring fine to coarse sand with little silt. Fuel odor was observed in the upper 4 feet of sediment, and in those sediments in the zone of water-table fluctuation.

Monitoring Well MW-4 is located in the parking area opposite Pier 12. In it, sand fill extended to about 10 feet, and was underlain by layers of sand and silty sand. All sediments above the water table had strong to very strong fuel odor. An interval of 0.5 feet thickness of sand appeared at the water table and appeared to be saturated with black fuel.

Monitoring Well MW-5 was installed opposite Pier 11, and indicated that silty sand fill occurrred to a depth of about 5 feet. This was underlain by relatively well sorted sand. A trace of fuel odor was observed from 3 to 5 feet and in the sediments at the water table.

Monitoring Well MW-9 is located in the parking area between Piers 16 and 17. It was installed after the monitoring wells at the Fuel Farm, when it was discovered that monitoring wells installed in the mid-1970's were plugged with sediment. Sand and silt fill occurred to a depth of about 8 feet, and these deposits were underlain by a thin layer of clay and layers of silty sand and well sorted sand. A slight fuel odor was observed in the sediments at the water table, but not in the overlying sediments.

Subsurface Fuel Volumes

In order to assess the potential problems resulting from the subsurface occurrence of fuel at Piers 11 and 19, it is necessary to estimate the volume of subsurface fuel and the degree of its existing and potential mobility.

As indicated in the preceding sections of this report, subsurface fuel was observed in each of the backhoe pits and test borings installed in the Piers 11 to 19 area (see locations, Figure 6). In each of the pits and test borings fuel was observed in the unsaturated soil above the zone of normal water-table fluctuation. In some cases, fuel occurred throughout the entire unsaturated zone; in other cases it only occurred in certain intervals.

This is consistent with what is known about fuel spillage in the area. Much of the waste fuel that was spread at the site would have percolated downward and become bound in the unsaturated zone by capillary action. In some cases, it would have seeped laterally after encountering a relatively impermeable zone.

An estimate of the volume of fuel occurring in the unsaturated zone has been made from both quantitative and qualitative observations made of sediment samples. The estimate is based on some statistical assumptions; its accuracy is therefore limited by a relatively small number of observations.

The volume of soil which is partially saturated with fuel has been estimated from the observation of split-spoon samples and backhoe pit samples as discussed previously. The number of feet of partially saturated sediment in each boring is shown in Figure 7. It is evident from Figure 7 that the thickness of partially saturated sediment ranged from 0 in MW-5 to 8 feet in MW-4. There was a general tendency for greater thicknesses to occur closer to the piers. The average partially-saturated thickness was 4.0 feet.

Based on these observations and the history of spreading waste fuels at the site, the overall area of partially-saturated fuel occurrence has also been estimated and is also shown in Figure 7. This is about 13 acres.

Four respresentative split-spoon samples from the unsaturated zone were analyzed for fuel concentration by a local laboratory. The results of these analyses are shown in Table 1 and Appendix D. A fifth sample (MW-4, 8-9 feet) was taken from the saturated zone. As Table 1 indicates, the fuel concentration in the unsaturated zone ranged from 0.02 to 0.19 percent by volume.

Assuming an average soil concentration of 0.105 percent, and the average affected thickness in the area outlined on Figure 7, it is estimated that the volume of fuel in the unsaturated zone is about 17,000 gallons.

In view of sampling limitations, the actual amount of fuel in the unsaturated zone near Piers 11 to 19 may differ considerably from this. Since the soil samples used for these analyses came from the borings which had the greatest thickness of contaminated sediments (Figure 1), they may be more representative of more highly contaminated areas. However, even if the lowest measured

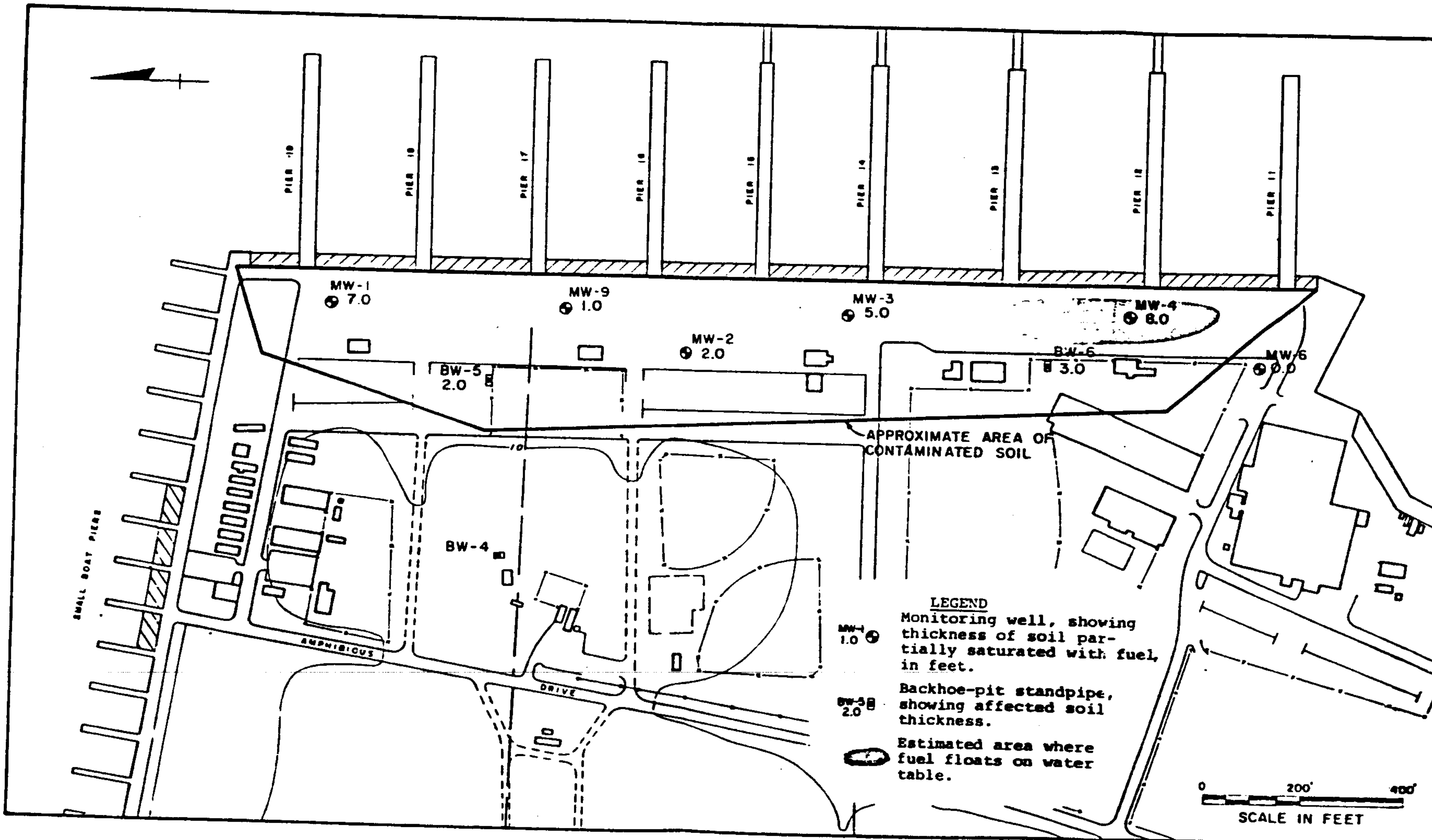


Figure 7: Pier 11-19 area, showing subsurface monitoring points and thickness of soil which is partially saturated with fuel, at each point.

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Table 1

Concentration of Fuel in Unsaturated Sediments

Volume percentage computed from weight percentage, assuming sediment porosity of 35% and fuel specific gravity of 0.85. Weight percent data shown in Appendix D.

Monitoring Well and depth, ft.	Volume %
MW-1, 4'-5'	0.16
MW-1, 8'-9'	0.02
MW-1, 10'-11'	0.03
MW-4, 6'-7'	0.13

concentration is assumed (0.02 percent), three thousand gallons of fuel appear to be suspended in the unsaturated zone. The actual amount probably is between 3000 and 15,000 gallons.

Free-floating fuel (pure or non-aqueous fuel floating on the water table) was found in MW-4 near Pier 12. This may have resulted from the vertical percolation and accumulation of waste fuels as described above. It may also have resulted from a leaky fuel pipeline. Under some circumstances, free-floating fuel can migrate to an area through gravel-filled pipeline excavations. However, in the case of MW-4, this appears to be unlikely. The probable movement of fuel will be discussed in the next section of this report.

The average observed thickness of free fuel in MW-4 was about 0.7 feet. For the slug to have this apparent thickness it almost certainly has an areal extent of at least tens of feet. However, as stated previously, free fuel was not observed in other monitoring points. On that basis, the estimated configuration of the free fuel slug is also shown in Figure 7. The apparent oblong shape of the slug may be a result of continuous tidal action, as discussed in the next section of this report. The estimated maximum area of free-fuel accumulation is about 0.8 acres (Figure 7).

Although it is difficult to verify, several authors have stated that the thickness of a fuel slug measured in a monitoring well is three to four times greater than that actually occurring in the nearby formation de Pastrovich and others, 1979; Williams and Wilder, 1971).

Therefore, if the actual slug thickness in the formation near the well is 0.17 to 0.23 feet, and the slug is at its thickest at that point, it may be assumed that the overall average thickness in the formation is about half that, or 0.08 to 0.11 feet thick.

If the moderately well-graded sand formation has a porosity of 35 percent, it is estimated that approximately 7600 to 10,000 gallons of fuel is floating on the water table in the vicinity of MW-4.

As with the estimation of fuel in the unsaturated zone, this estimation is based on a small amount of information. The areal extent of the fuel slug, as shown in Figure 7, is probably an upper limit. Therefore, it is probably safe to assume that 7600 to 10,000 gallons is the maximum volume of free-floating fuel.

Subsurface Fuel Mobility

For some years fuel has occurred at Piers 11-19 with no serious adverse affect. However, the potential for future problems has been uncertain. The question remains whether fuel could become remobilized in such a way as to enter the ship wastewater sewer in harmful quantities.

As indicated in the previous section of this report, samples from eight sampling points suggest that fuel occurs almost ubiquitously in the unsaturated zone (above the water table) near the piers. It is probably still distributed in a way which reflects the manner in which it was orginally spread as waste oil. The fuel was observed in silty, clayey material as well as in sand.

When the oil was spread, much of it would have seeped downward under the influence of gravity. The wetted surface of the oil would have increased until such time that capillary forces equalled gravitational ones. In some cases oil may have seeped down to the water table before the capillary forces became dominant. At that point it would have spread laterally along the water table.

Since the remaining fuel is bound by capillary forces in the unsaturated zone, there is little remaining potential for it to flow on its own. This would be especially true in fine-grained, poorly sorted sediment where intergranular pores tend to be very small and capillary forces tend to be relatively large.

However, subsequent mobility of fuel in the unsaturated zone would be expected to occur as a result of flushing by another seeping fluid. The infiltration of either more waste oil, precipitation, or other fluids would result in the release of additional fuel from the unsaturated zone.

Since the area in question is essentially all paved, however, it is unlikely that fuel would be released from the unsaturated zone as a result of any continued flushing action. Therefore, although thousands of gallons of fuel occur in the unsaturated zone above the water table in the Pier 11-19 area, it is largely immobile due to the pavement cover. It is highly unlikely that significant amounts of fuel in the unsaturated zone could become mobilized, thereby causing any sort of problem.

As described previously, free-floating fuel occurs on the water table in the vicinity of Pier 12. Its mobility is closely related to that of groundwater in the area.

In order to determine the characteristics of the groundwater flow system in the pier area, water table levels were periodically measured in all monitoring points near the piers. Average water table levels are shown in Figure 6. The water table typically occurs from 7-9 feet below the ground surface, or at an elevation of 2-3 feet above mean sea level. Based on these elevations and local topography, it is inferred that groundwater generally flows eastward through the pier area, prior to discharging into the Cove (Figure 6).

Under other circumstances, the water table would be expected to be essentially at sea level within 100 feet or so of the Cove. However, a combination of factors appear to be responsible for maintaining the average water level a few feet above sea level near the piers.

Natural groundwater flow would normally be horizontal so near to its point of discharge into surface water. It is likely that the concrete ramps at the water's edge have effectively dammed this type of flow. However, in order for it to discharge beneath the ramps, groundwater must achieve a vertical flow component. But, the vertical flow tends to be inhibited by naturally occurring stratification. This results in a build-up of head in groundwater beneath the eastern part of the parking area as illustrated schematically in Figure 8.

The damming effect has probably prevented the observed fuel in the saturated zone from discharging into the Cove. The fuel slug remains floating on the water table, while groundwater continues to flow beneath it and discharge into the Cove. The slug cannot flow westward because of the upward slope of the water table in that direction. This results in the slug having an elongate shape parallel to the shore, as shown in Figure 7.

While this situation apparently reflects general conditions beneath the parking lot, there are short-term changes which result from tidal activity. Typical water table fluctuations over the course of one day are shown in Figure 9, based on

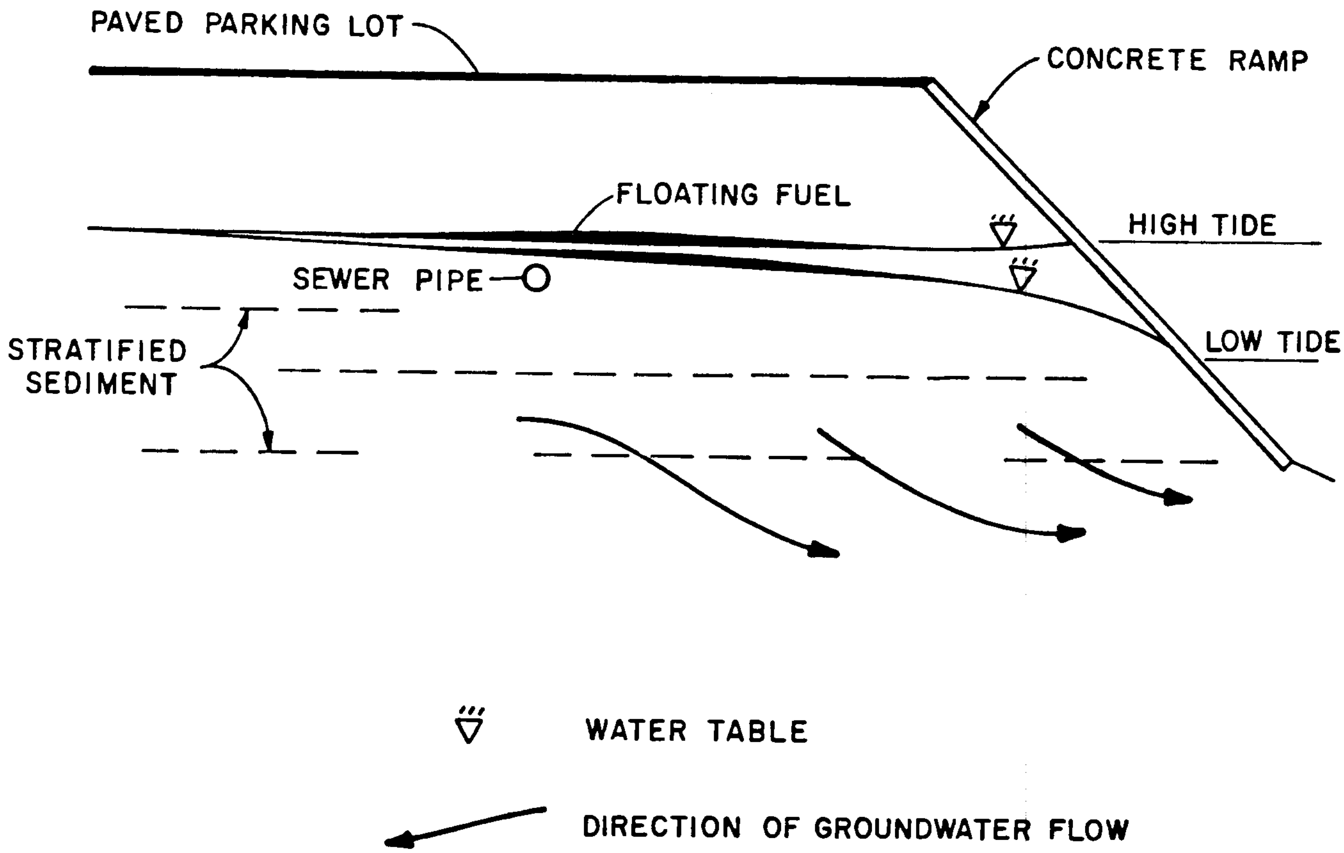

Figure 8: Schematic cross section showing groundwater system and floating fuel beneath parking area near Piers 11-19.

measurements of four monitoring wells near the piers. Two of the wells closest to the Cove, MW-1 and MW-3, show a tidal fluctuation which is delayed about one hour from that in the Cove. The amplitude in them is about 1/10 of that in the Cove, or about 0.25 feet.

Monitoring well MW-2 is located about 200 feet from the Cove (Figure 6). Water level measurements indicated that the average head measured in it was about 2.25 feet (above sea level); however, no tidal fluctuation was evident. Water level measurements were generally accurate to about 0.05 feet.

Figure 9 also illustrates head changes in MW-4, where floating fuel occured. Fluid level measurements were corrected for fuel density. It is evident from Figure 9 that the amplitude of tidal fluctuation in MW-4 was about the same as that observed in other wells close to the Cove. However, the elevation of the top of the fluid was more similar to that in the well (MW-2) farther from the Cove. This reflects the thickness of the floating fuel slug.

Head conditions in MW-4 are shown in more detail in Figure 10. The groundwater surface (water table) generally fluctuated between elevations of 1.5 and 2.0 feet, as it did in MW-1 and MW-3. The fuel surface fluctuated between 2.25 and 2.50 feet. As Figure 11 illustrates, the fuel slug thickness was proportional to tidal stage, being about 0.5 feet at high tide and 0.8 feet at low tide.

To some extent this thickness change may reflect hydraulic conditions immediately around and in the monitoring well. However, it probably also indicates that the fuel slug as a whole alternately disperses and contracts with each tidal wave.

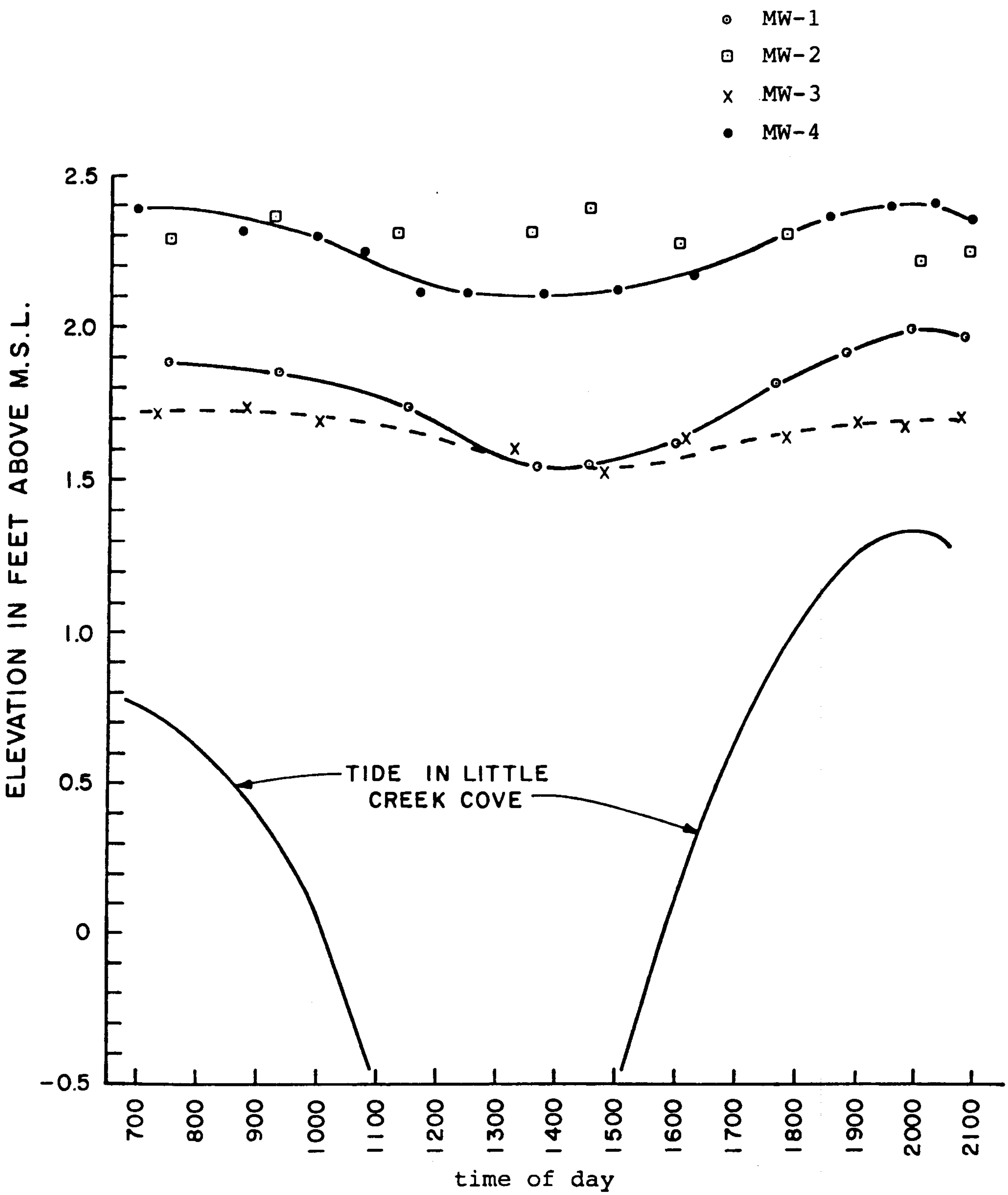

Figure 9: Water table stage in four monitoring wells on August 31, 1982. Tidal level in Little Creek Cove is also shown.

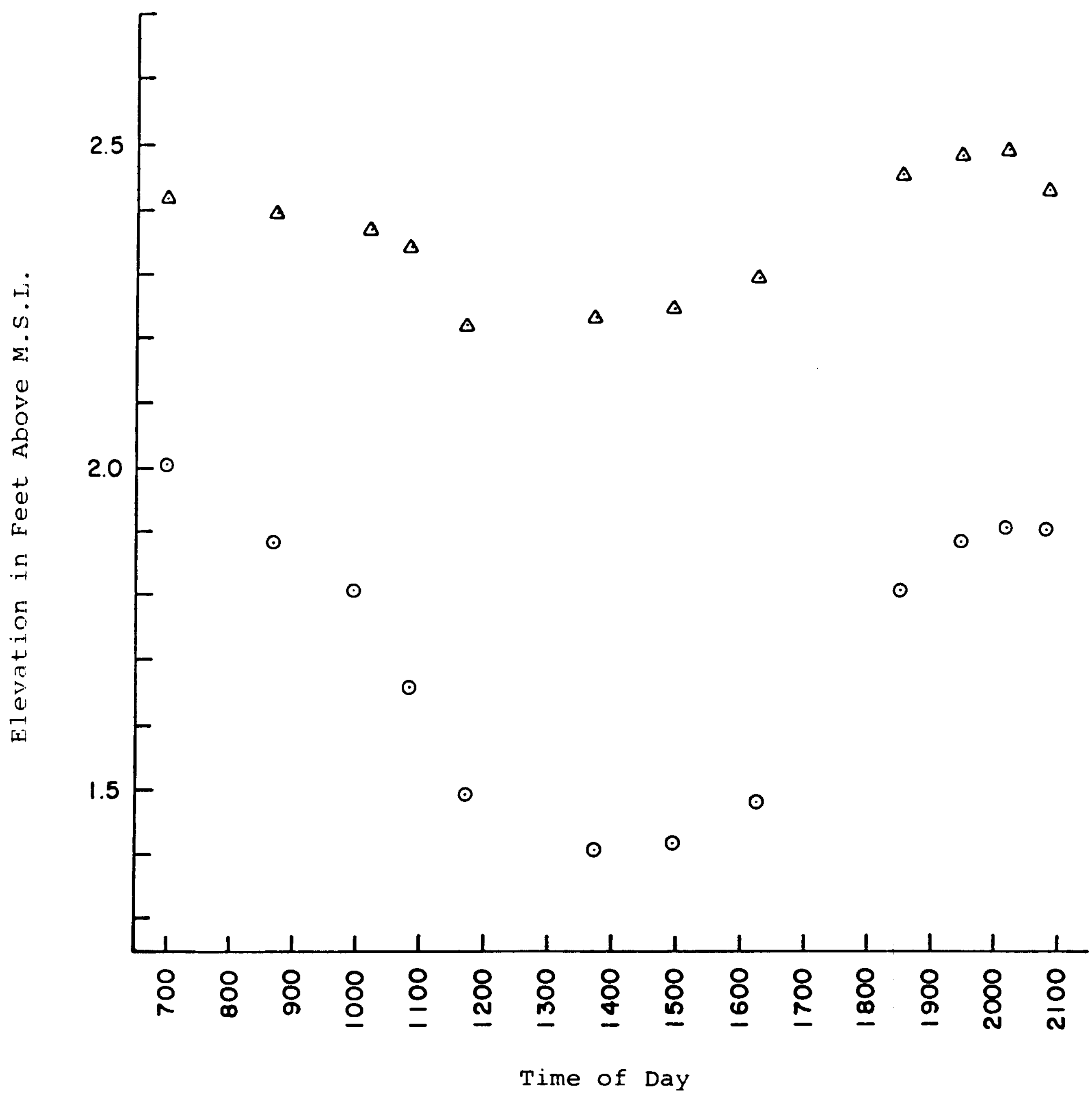

Figure 10: Elevation of floating-fuel surface, and fuel/water interface, versus time of day in MW-4. Measured August 31, 1982.

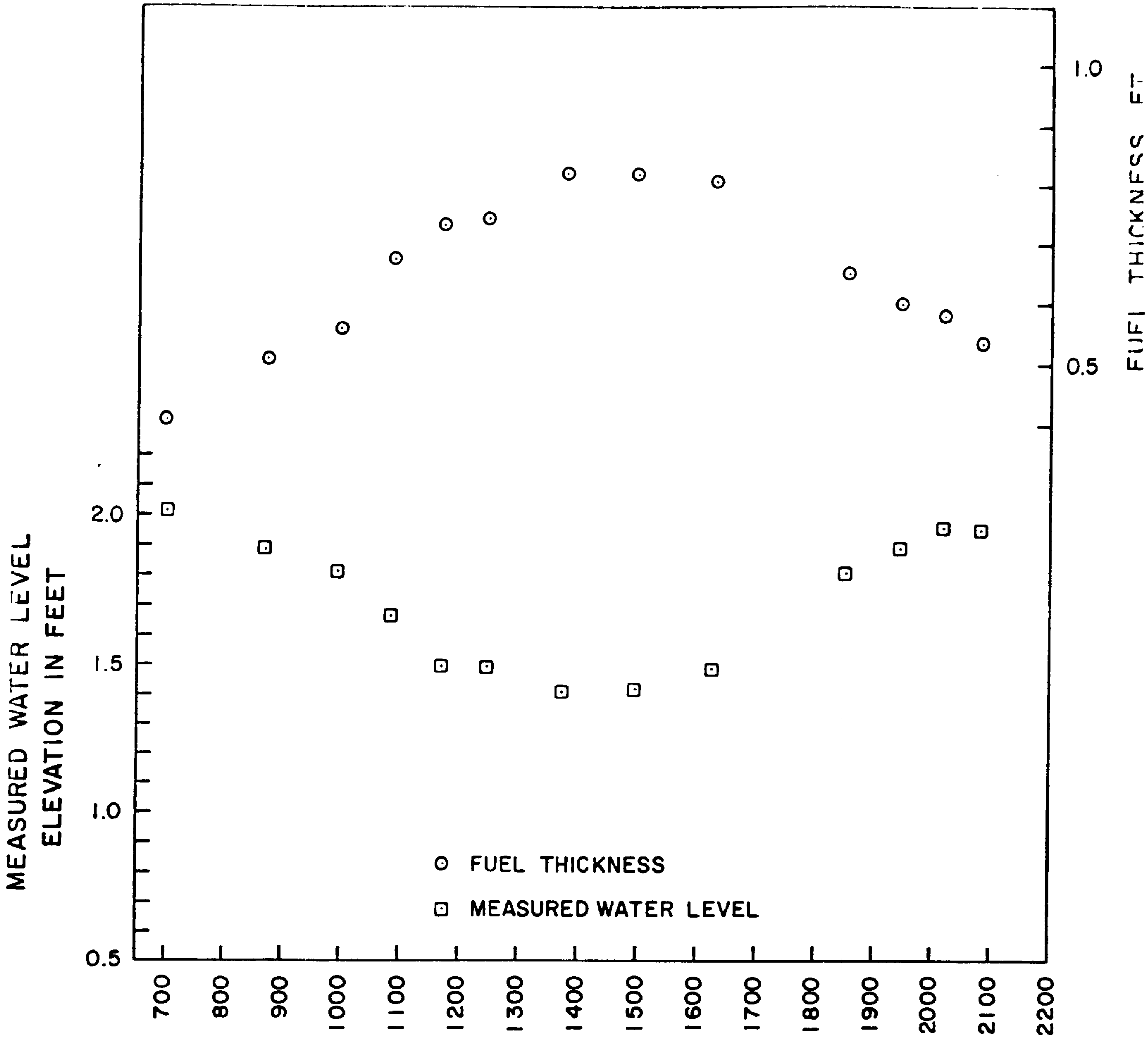

Figure 11: Elevation of fuel/water interface and fuel-slug thickness, versus time of day in MW-4 - Measured August 31, 1982.

The floating fuel can enter the ship wastewater sewer, of course, only where the fuel slug and the sewer coincide. In places where the sewer has been installed well above or below the zone of (water table) tidal fluctuation, it can be expected that little potential exists for an influx of floating fuel.

Sewer profiles reproduced in Figure 12 show the relationship between the location of the sewer and the probable location of the fuel slug near Pier 12. Based on available information it seems evident that the main sewer line is generally situated below the zone of water table fluctuation. There appears to be some sewer line coincidence with the water table between Piers 11 and 12, however. There is also coincidence with the laterals that connect the line to Piers 12 and 13 and with Manholes 18 and 19. Most other utilities are apparently situated above the zone of water table fluctuation.

The greatest potential for fuel influx into the ship wastewater sewer is in those places near Pier 12 where the floating fuel occurs at the same elevation as the sewer. These areas are shown in Figure 13.

In the Pier 11-19 area as a whole, the zone of water table fluctuation coincides with the sewer line at both ends of the area and at manholes and laterals. These areas are also shown in Figure 13, and would be potential entry points if floating fuel is present there.

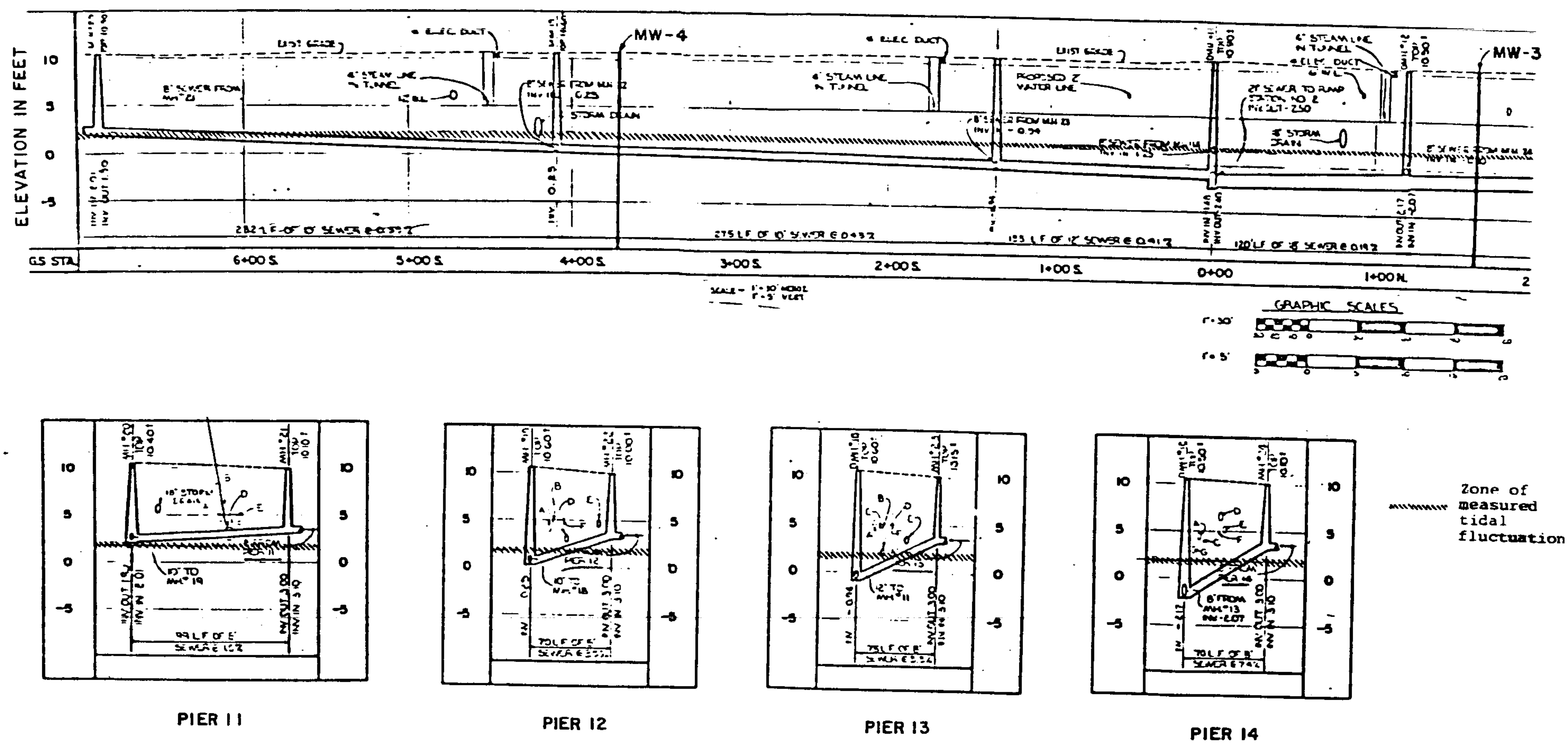

Figure 12: Sewer profiles from the Pier 11-14 area, showing zone of measured tidal fluctuation. Floating fuel could enter the sewer where the zone of tidal fluctuation intersects the sewer.

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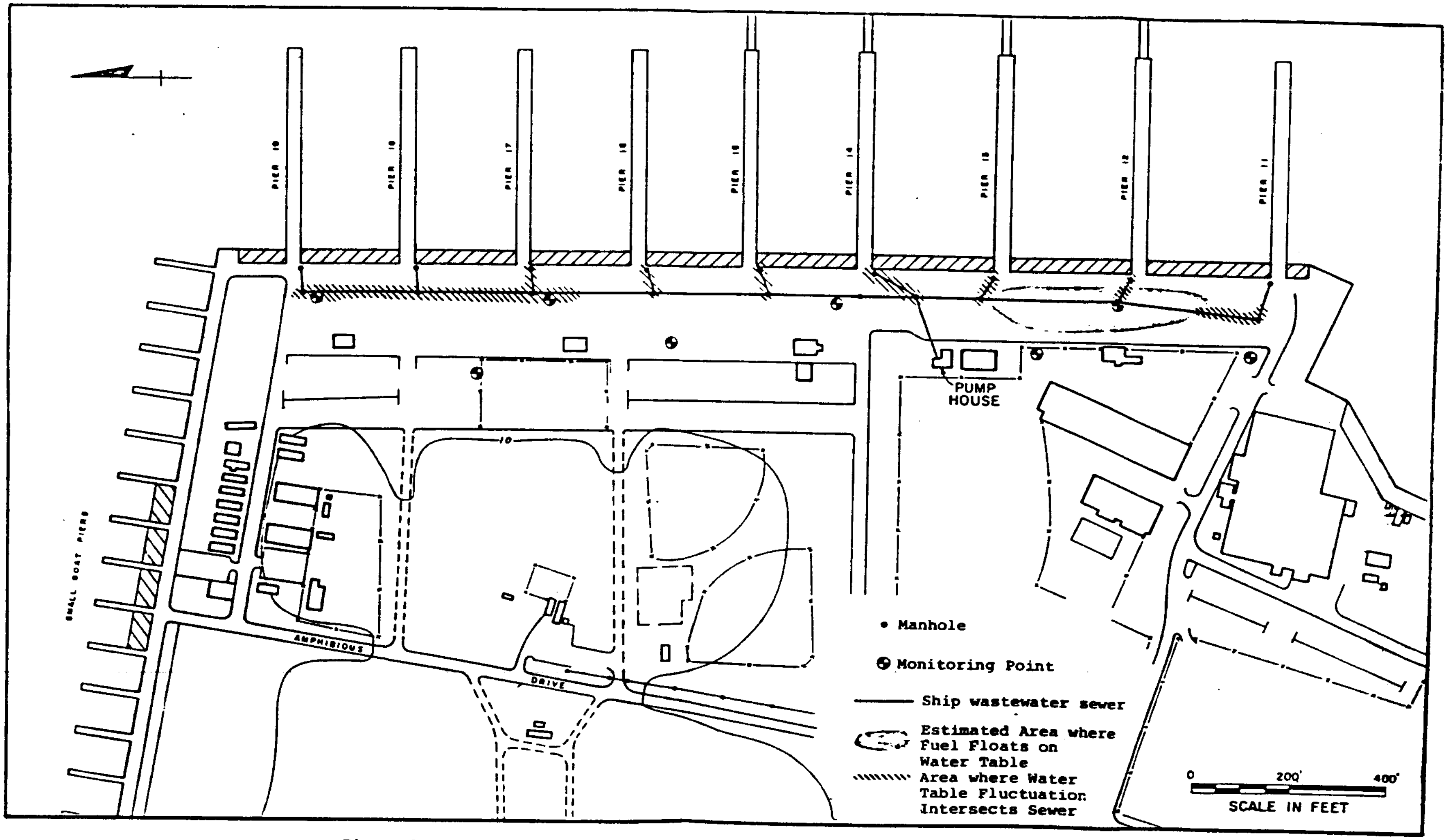

Figure 13: Pier 11-19 area, showing location of ship wastewater sewer, estimated area of floating fuel slug, and areas where water table intersects sewer.

r.e. wright associates, inc.

REMEDIAL MEASURES

As described in the preceding sections of this report, rather large amounts of subsurface fuel occur in both the unsaturated zone and the saturated zone beneath the parking area at Piers 11-19. Fuel in the unsaturated zone is generally immobile and poses little threat to the environment or to the ship wastewater sewer. Fuel in the saturated zone near Pier 12 is more mobile and could enter the sewer in some places.

Even though fuel in the unsaturated zone does not pose any significant threat, possible remedial actions will be discussed in the following sections for both the unsaturated and saturated zones near Pier 12. A sense of the available remedial options for the unsaturated zone will aid an understanding of recommendations presented in the final part of this report.

Unsaturated Zone

The removal of fuel from the unsaturated zone near Piers 11-19 would be technically difficult for two main reasons. First, the fuel occurs in low, variable concentrations in sediment beneath a very large area. Second, most of that area lies beneath a large, heavily used parking lot. Access to the subsurface would therefore be difficult.

Two methods are commonly used to remove fuel from the unsaturated zone. The first is to hydraulically flush fuel from the unsaturated zone by encouraging the infiltration of water at a relatively higher rate.

In this case, water would have to be injected into closely spaced well points located throughout the affected area. In order to achieve the necessary flushing at all levels, well points would be made to penetrate to depths of only a few feet, thereby permitting the injected water to flow down along the same flow paths that the fuel had taken. The result would be to create a thin layer of fuel floating at the top of the saturated zone throughout the area. The fuel would then have to be removed by pumping from wells into an oil/water separator.

It is estimated that the well points would have to be spaced in a grid on about 20 foot centers. Thus, nearly 1500 well points would be required for full coverage of the area. Even if it were done in stages, this would clearly be an intensive effort that is not warranted by the severity of the problem in the unsaturated zone.

The second method to be considered for the unsaturated zone is the enhancement of fuel biodegradation. This would be achieved by the addition of commercially available mutant bacteria and nutrients to the soil. Specialized bacteria would consume the fuel, effectively removing it from the environment.

For biodegradation to be effective, however, a flushing system would be required. It would essentially be similar to the well point flushing system previously described. Oxygenated water would have to be injected by way of shallow well points and allowed to percolate through the unsaturated zone. Water would also have to be pumped out and recirculated.

Although the removal of fuel could be achieved more quickly with biodegradation than with a straight flushing system, months of intensive labor would be required and the estimated cost to do this would be $300,000.

Thus, in view of the relatively small problem posed by the fuel in the unsaturated zone, and the impracticality of dealing with it, its removal is not considered further in this report.

Saturated Zone

The proximity of floating fuel to the ship wastewater sewer near Pier 12 is cause for greater concern than the fuel in the unsaturated zone. Remedial options discussed below would be intended to remove the fuel from the saturated zone, thereby eliminating the potential for sewer influx.

Biodegradation

Mutant bacteria used for fuel biodegradation require moisture, yet are almost exclusively aerobic. Rates of biodegradation are therefore proportional to the degree to which a fluid medium is oxygenated. In the case of free-floating fuel, most bacterial activity occurs at the fuel/groundwater interface.

Since the area of this interface is relatively small compared to exposed areas in the unsaturated zone and since groundwater generally has little oxygen dissolved in it, rates of biodegradation in the saturated zone are normally low. The rate can be increased by the injection of oxygenated water, but the gains achieved by this do not generally warrant the effort. In short, biodegradation is effective on free-floating fuel, but generally at rates which make it inefficient.

Interceptor Trenches

An interceptor trench can sometimes be used to collect subsurface fuel if a significant hydraulic gradient toward it is present or is created by pumping groundwater. The method is frequently advantageous in places where the water table is shallow and where there are no limitations on extensive digging.

The area near Pier 12 is clearly not suited for trenches, however. It is paved, heavily used, and has numerous underground utilities. It is also doubtful that the sediments would be competent enough for a trench to remain open to a depth of more than 9 feet for a prolonged period.

Cutoff Wall and/or Underdrain Collection

This type of system is sometimes used to stop the flow of contaminated water. The cutoff wall would probably consist of a subsurface bentonite slurry wall, installed in a trench downgradient from the affected groundwater. Underdrains could be used to collect fuel and groundwater, and to prevent its escape from the cutoff area.

Such a system is also unwarranted in this situation. As described previously, the slug of floating fuel is relatively stationary. Thus, the concrete ramps essentially serve as a cutoff wall and a second cutoff would serve no purpose.

Recovery Wells

When groundwater is pumped from recovery wells, a cone of drawdown is created which also induces the flow of floating fuel into or toward the recovery well. fuel will collect on the water's surface in the well, and can be recovered with a second pump or with a bailer.

The use of wells to collect floating fuel is advantageous because their use is flexible while being effective. They can be installed easily and sequentially, if necessary, in response to new information about fuel occurrence and mobility. In a heavily used area like that near Pier 12, they can be made unobtrusive by being installed in manholes.

Monitoring well MW-4 was tested in an effort to determine the viability of using recovery wells near Pier 12. In the first test, 0.88 feet of floating fuel was removed from the well with a bailer. Groundwater in the well was not pumped, however. The rate of fuel influx into the well was recorded, and is shown in Figure 14.

Figure 14 indicates that about 0.2 feet of fuel entered the well soon after it was bailed. This probably originated in the sand pack installed around the well screen. Fuel continued to flow into the well at decreasing rates; 1500 minutes (1 day) after the bailing, about 0.6 feet had re-entered the well.

An inflow test was also conducted by pumping MW-4 for a relatively brief period. While groundwater was pumped from the bottom of the well, the thickness of the fuel slug was periodically measured on the water surface. The water level in the well was drawn down about 4 feet. Sustained pumping was hampered by the monitoring well's low yield and by mechanical problems with the pump.

Pumping commenced with 0.6 feet of fuel floating in the well. Much of this fuel disappeared as the well was drawn down. Figure 15 shows that about 0.1 feet of fuel was measured in the

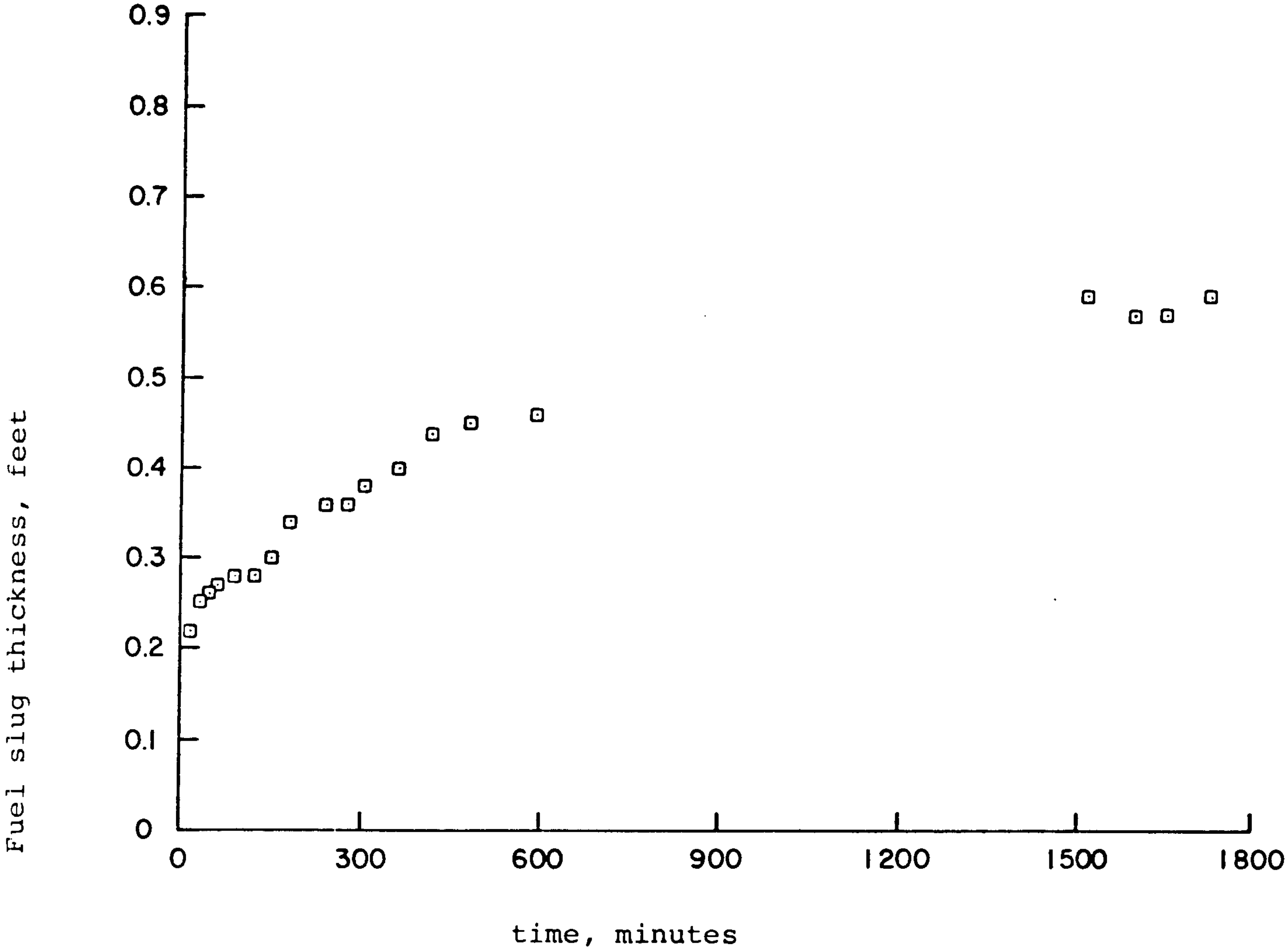

Figure 14: Recovery of fuel slug thickness in MW-4 after slug was bailed. Initial slug thickness 0.88 feet.

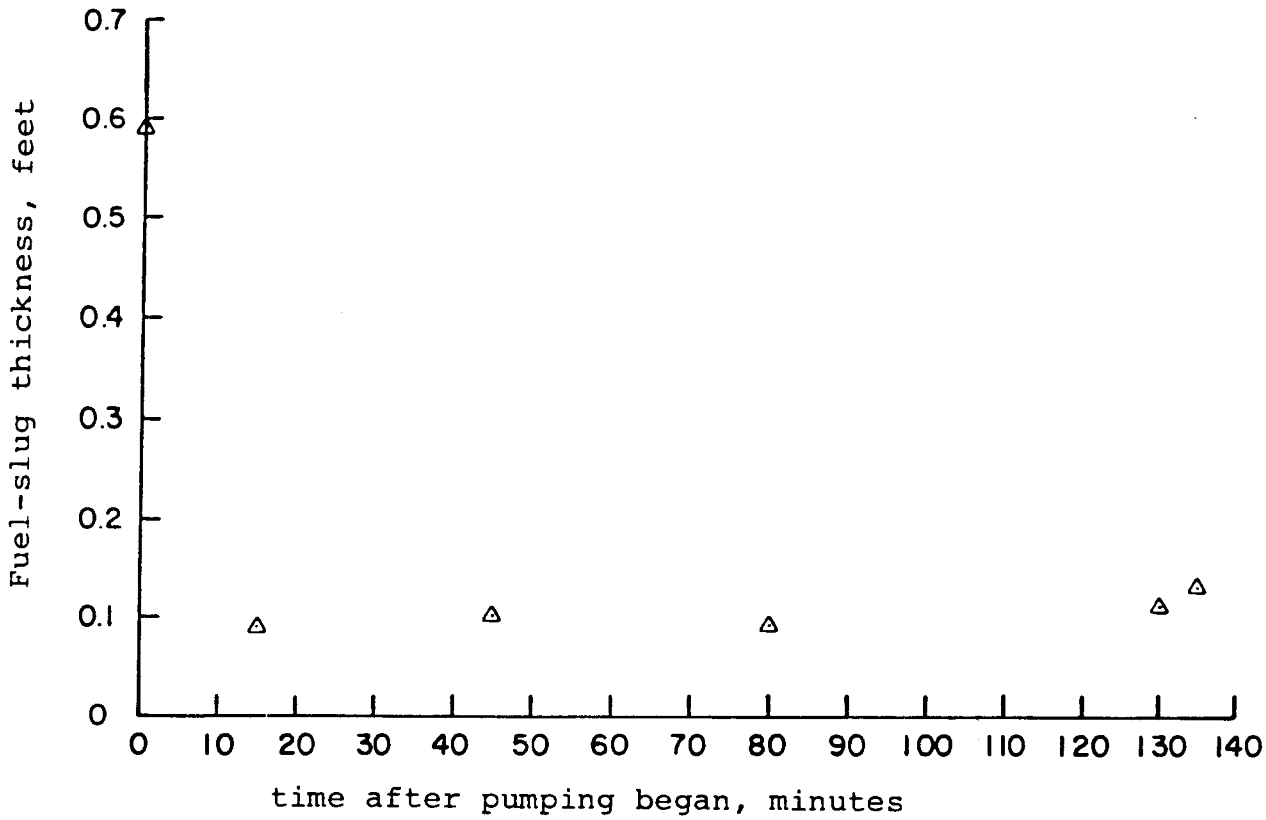

Figure 15: Change of fuel-slug thickness in MW-4 when water level in well was drawn down four feet. Initial slug thickness 0.59 feet.

well soon after pumping began. After 140 minutes of pumping, the fuel thickness remained at 0.1 feet; therefore, however, virtually no fuel entered the well during pumping.

It is likely that when the water table was drawn down in the sediment around the well, fuel was left suspended above the new pumping level by capillary action, thereby immobilized. The tendency for this to happen depends on the thickness of the floating fuel in the formation, the amount of drawdown, and the textural characteristics and stratification of the sediment. Soon after pumping ceased a slight influx was observed.

Due to limitations in the hydraulic efficienty of small diameter monitoring wells, and the resulting short duration of this pumping test, it is difficult to generalize about the effects of well pumping on fuel influx rates. However, based on the results of this test, it seems that fuel can effectively be induced into a recovery well if drawdown in the well is kept to a minimum. It appears that recovery would best be accomplished by continuously bailing free-floating fuel from the water surface in the well, without lowering the water table at all. In practice, however, it may be found that a small amount of drawdown would hasten the rate of influx.

Fuel recovery rates would be expected to be fairly low, on the order of tens of gallons per day per well. To speed up the rate would probably require the installation of more than one recovery well, but this should be determined only after testing an actual recovery well. A properly designed and constructed recovery well would be essential for effective recovery. It should be at least six inches in diameter and have a gravel pack at least two inches thick.

SUMMARY AND CONCLUSIONS

A hydrogeologic investigation was performed to delineate the extent of fuel in the subsurface at the Little Creek Naval Amphibious Base. Of particular interest was the nature of subsurface fuel in the area near Piers 11-19, and the potential for it to enter the ship wastewater sewer and subsequently enter the Hampton Roads Wastewater Treatment Plant. Also, the degree of subsurface fuel occurrence near the Fuel Farm, the Steam Plant, and Tank 1551 (Figure 1) was investigated.

Field work was planned on the basis of the existing information concerning subsurface fuel, and on hypotheses regarding possible fuel occurrence and mobility. In the initial phase of field work eleven backhoe pits were dug in an effort to find subsurface fuel. They also permitted a rapid description of soil and groundwater conditions.

Six standpipes were installed in those backhoe pits where the water table was reached and where they would not be in the way. They were used to measure the accumulation of floating fuel on the water table, and to measure water table elevations.

Nine test borings were drilled and monitoring wells were installed in those places where backhoe pits and/or standpipes could not be used because of local conditions. Continuous split-spoon samples were used to delineate fuel occurrence and stratigraphy. Measurements of floating fuel occurrence and water table elevations were made in the monitoring wells (Figure 2).

At the Steam Plant three backhoe pits were dug near fuel storage tanks and fuel pipelines (Figure 3). Standpipes, test borings, and monitoring wells were not installed. No fuel is observed in the pits, either in sediment or groundwater. Based on these observations, significant amounts of fuel do not occur in the subsurface at the Steam Plant, and no further action is warranted at this time.

At the Fuel Farm, two backhoe pits and three monitoring wells were installed (Figure 4). Standpipes were not installed. No fuel was observed, either in sediment or groundwater. Based on these observations, significant amounts of fuel do not occur in the subsurface at the Fuel Farm. Therefore, no further action is warranted at this time.

Tank 1551 is used for ship fuel storage, and is located west of Piers 11-19 (Figure 5). Three backhoe pits were dug near it, and standpipes were installed in all of them. No fuel was observed in sediment or groundwater. Based on these observations, there is no significant amount of fuel in the ground near Tank 1551. No further action is warranted at this location.

A single backhoe pit was installed near a collection pond at the Fueling Depot on Amphibious Drive west of Piers 11-19 (Figures 5 and 6). Small amounts of fuel were observed in sediment and groundwater, which probably originated in the catch basin. However, it appears to be in small enough amounts and far enough from the pier area so as to have little potential to discharge into the sewer line or the cove.

There is a history of fuel leakage and intentional fuel disposal in the vicinity of the parking area near Piers 11-19. Based on this, two backhoe pits and six test borings and monitoring wells were installed in the area (Figure 6). Fuel was observed in soils from above the water table at all of these monitoring points. Fuel was also observed floating on the water table in Monitoring Well MW-4, near Pier 12 (Figure 7).

An estimate of the total volume of fuel in partially saturated sediment (above the water table) has been made from qualitative observations at the monitoring points and from quantative measurements made on four split-spoon samples. The volume of fuel in the unsaturated zone beneath the 13-acre parking area is probably about 10,000 gallons.

Fuel in the unsaturated zone is generally bound by capillary action. Under other circumstances it could be flushed down to the water table by other infiltrating fluids. However, pavement prevents such infiltration in most of the affected area. It is highly unlikely that significant amounts of fuel in the unsaturated zone could become mobilized.

An estimate has also been made of the volume of fuel floating on the water table near Pier 12, based on measurements in MW-4. It is apparent that thousands of gallons are present there, probably on the order of as much as 10,000 gallons.

The mobility of floating fuel is largely dependent on the nature of the local groundwater system. Natural groundwater discharge to Little Creek Cove beneath the piers is inhibited by concrete ramps at the water's edge and by natural soil stratification (Figure 8). This has resulted in a rise of the water table to a level significantly above the tidal level in the adjacent Cove. This buildup, plus a natural water table gradient toward the east, appear to have trapped the floating fuel, thereby preventing its discharge into the cove.

Water table levels within a hundred feet of the cove show a distinct tidal response (Figure 9). The thickness of the fuel slug in MW-4 also varied with tidal stage, being thicker at low tide (Figures 10 and 11). This may reflect a periodic expansion and contraction of the fuel slug, or the movement of the entire slug in response to tidal waves.

Profiles of the ship wastewater sewer indicate that the sewer intersects the zone of water table fluctuation in some places (Figures 12 and 13). In those places, the potential for floating fuel to enter the sewer would be greatest.

Two remedial procedures have been discussed for the fuel in the unsaturated zone near Piers 11-19. These are hydraulic flushing and biodegradation. Flushing would require hundreds of well points, complex (albeit temporary) plumbing, and a well collection array.

Biodegradation would require essentially the same system for the maintenance of mutant bacteria. Local conditions would substantially reduce the effectiveness of either system. In view of the small potential for problems resulting from fuel in the unsaturated zone, remedial measures for that zone should not be considered any further.

Abatement options have also been evaluated for the floating fuel near Pier 12. Biodegradation is generally not an efficient means for removal of fuel from the saturated zone. An interceptor trench is not suitable because the area is heavily used, paved, and has numerous utilities underground. A cutoff wall and/or underdrain collection system would not be necessary since the fuel is essentially immobile, except for sewer line access. Such a system would also be unnecessarily complex and expensive.

Recovery wells would be a flexible and inexpensive means to collect and recover floating fuel. Monitoring Well MW-4 was tested in an effort to determine the effectiveness of wells for this purpose at the site. In one test, fuel was bailed from the well but groundwater was not pumped. Fuel re-entered the well at a rate which suggests that fuel could slowly be recovered by this method (Figure 14).

In another test, groundwater was pumped from MW-4, thereby establishing a cone of drawdown. During the pumping period there was little or no influx of fuel into the well (Figure 15). Fuel in the nearby formation probably became suspended in the capillary zone above the pumping level.

Based on this it seems that fuel can be effectively collected by a recovery well near Pier 12, if drawdown is kept to a minimum; this can be accomplished by bailing the well continuously. The existing monitoring wells will not be effective for fuel collection. With the installation of a properly designed and constructed well, fuel recovery rates would be expected to be on the order of tens of gallons per day.

RECOMMENDATIONS

1. No effort should be undertaken to remove fuel from the unsaturated zone near Piers 11-19, until it is demonstrated that such fuel causes problems or has the potential to do so.

2. Fuel which is floating on the water table near Pier 12 should be removed from the subsurface. This should be done by the procedures outlined below. The estimated costs for this program are indicated on Form 1391, which follows this narrative.

A. Additional monitoring wells should be installed within a a few hundred feet of MW-4 in order to define the shape and size of the fuel slug. It is anticipated that three to five additional monitoring wells will be sufficient for this purpose. The first monitoring well should be installed next to the ship wastewater sewer near Pier 13. Subsequent well installation should be guided by observations made in this new well and MW-4.

B. The additional monitoring wells should be tested for rate of fuel influx in the same manner as described in this report. This should include fuel-thickness measurements following the bailing of fuel from a well, and during a period of water table drawdown.

C. Depending on the results of the above outlined preliminary investigation, one or more fuel recovery wells should be installed. In order to remove fuel at a relatively efficient rate, this well(s) should have a casing diameter of at least 6 inches, and a gravel pack diameter of at least 10 inches.

D. The recovery well(s) should be continuously bailed in such a way as to maximize the rate of fuel influx. Measurements in MW-4 suggests that this will involve minimal water table drawdown. However, this should be verified by testing the recovery well. Rates of fuel influx should be determined for different amounts of water table drawdown in the well; the optimum amount of drawdown should be stabilized. An automatic mechanical bailer should be used to continuously remove fuel from the water table. Effluent from the recovery well(s) should be discharged into a portable oil/water separator; fuel should then be removed from the site.

3. Existing and potential occurrence of subsurface fuel should be monitored regularly using the monitoring wells and standpipes installed during this investigation. This should be done by sniffing the well casings and standpipes, and by using a transparent interface sampler such as one produced by Oil Recovery Systems, Inc. (approximately $75), or equivalent. Wells and standpipes near Piers 11-19 should be checked monthly. Those near Tank 1551 and at the Fuel Farm should be checked semi-annually.

4. The Virginia State Water Control Board requires notification in the event that any fuel is found underground. The Tidewater Regional Office should be contacted. This report should provide any documentation they require, prior to a fuel recovery effort.

REFERENCES CITED

de Pastrovich and others, 1979; Protection of Groundwater from Oil Pollution; CONCAWE, Den Haag.

Williams, D.E., and Wilder, D.G. 1971; Gasoline Pollution of a Groundwater Reservoir, a Case History, Groundwater Vol. 9 No. 6.

1. COMPONENT	FY 19__ MILITARY CONSTRUCTION PROJECT DATA	2. DATE
NAVY		Oct., 1982

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
Little Creek NAB, Virginia Beach, VA	Subsurface Fuel Removal, Piers 11-19 Area

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
---	----	----	$36

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
Monitoring Wells	ea.	3	500	1.5
Recovery Wells	ea.	2	2500	5.0
Well Pumping Equipment	LS	2	1000	2.0
Continuous Fuel Bailers, rental for 6 months	Week	2 x 24 wks.	150	8.0
Bailer Maintenance and Labor	hr.	250	25	6.3
Hydrogeologic Consulting Services plus expenses	hr.	250	35	10.0
Subtotal				32.8
Contingency (10%)				3.3
TOTAL				36.1

10. DESCRIPTION OF PROPOSED CONSTRUCTION

1. Install additional monitoring wells to better define extent of fuel floating on water table near Pier 12.

2. Perform hydrogeologic testing on new monitoring wells to finalize site-specific characteristics of fuel recovery system.

3. Install cne or two fuel collection wells.

4. Bail collection wells continuously until floating fuel no longer has potential to enter ship wastewater sewer.

APPENDIX A

Backhoe Pit Logs

BP-1

Location: 30 feet northwest of Tank 1551

Depth	Unified Classification	Description
0 - 4.4'	SP	Sand Fill, medium brown; little silt, friable, slightly moist, contains brick, pipe, and wood fragments; no fuel observed.
4.4 - 8.5+'	SP	Sand Fill, medium to dark gray; coarse sand, little silt, contains some boulders; groundwater influx at 6.6'; no fuel observed.

BP-2

Location: 25 feet southwest of Tank 1551

Depth	Unified Classification	Description
0 - 0.7'		Topsoil.
0.7 - 1.7'	SP	Sand Fill, orange-brown; very fine to coarse sand, some silt, little cobbles, stiff, moderately moist; no fuel observed.
1.7 - 4.7'	SP	Sand Fill, light brown; as above, less silt, somewhat friable, moderately mottled in lower 0.5 feet; no fuel observed.
4.7 - 7.0'	SP	Silty Sand, medium dark gray; coarse sand, little fine sand, little silt, some very silty pockets, moist; no fuel observed.

7.0+'	SP	Sand, very light gray; medium to coarse, saturated; no fuel observed.

BP-3

Location: 20 feet north of Pump House near Tank 1551

Depth	Unified Classification	Description
0 - 3.7'	SW	Sand Fill, variable brown; medium to coarse sand, little silt, little pebbles, little organic material; no fuel observed.
3.7 - 4.9'	SP	Sand Fill, medium gray; coarse, very well sorted, few pockets of dark gray silty clay; no fuel observed.
4.9 - 5.8'	CL	Silty Clay Fill, dark gray and orange; causes perched groundwater system; no fuel observed.
5.8 - 6.5'	SP & CL	Sand and Silty Clay Fill; as above; no fuel observed.
6.5 - 11.0'	SP	Sand Fill, light gray with pockets of brown; coarse, little fine sand, trace silt; saturated; no fuel observed.

BP-4

Location: 20 feet northeast of catchbasin near loading racks between Tank 1551 and Pier 17

Depth	Unified Classification	Description

0 - 0.9'	Pt	Top soil
0.9 - 2.8'	SP	Sand Fill, light brown; coarse, well sorted, trace silt; no fuel observed.
2.8 - 5.5'	SW	Sand Fill, light gray to black; fine to coarse, little silt, little organic debris, with some pockets of dark gray silty clay; perched groundwater caused by silty clay pockets; trace fuel odor.
5.5 - 11.0+'	SW	Silty Sand, brown and gray; fine to coarse sand, some silt, many roots, moderately cohesive; much groundwater seepage in coarse-grained pockets; trace oil sheen on groundwater.

BP-5

Location: 50 feet west of paved parking lot, between Piers 17 and 18

Depth	Unified Classification	Description
0 - 1.7'	SP	Sand Fill, light to dark brown; coarse sand, moderately well sorted, variable silt concentration; no fuel observed.
1.7 - 4.2'	SP	Sand Fill, very light gray to dark gray; coarse, well-sorted, friable; no fuel observed.
4.2 - 7.0'	ML	Clayey Silt Fill, orange-brown; little sand, few boulders, stiff; lower 1-foot somewhat mottled with

		gray clay silt; no fuel observed.
7.0 - 10.0'	SP	Sand, medium gray; coarse sand, trace fine sand, well sorted; saturated; increasing fuel odor with depth, especially in fine-grained pockets.

BP-6

Location: 15 feet west of pavement, opposite Pier 13

Depth	Unified Classification	Description
0 - 1.0'	SM	Sand Fill, orange-brown; fine to medium sand, some silt, trace clay, stiff; no fuel observed.
1.0 - 2.5'	SM	Sand Fill, dark gray; as above, more clay in pockets.
2.5 - 6.0'	ML	Clayey Silt Fill, orange-brown; little fine to coarse sand, little clay, very stiff; no fuel observed.
6.0 - 7.0'	SP	Sand, medium brown; medium sand, trace silt, moderately soft and moist; slight fuel odor.
7.0 - 9.5+'	SP	Sand, medium to dark gray; Distinct fuel odor.

BP-7

Location: Steam Plant 40 feet north of western Fuel Tank, north of plant

Depth	Unified Classification	Description
0 - 0.5'	GW	Gravel Fill
0.5 - 1.7'	SM	Silty Sand, dark gray; fine to medium sand, some silt, little clay, with pockets of silty clay, soft, moderately cohesive; no fuel observed.
1.7 - 2.7'	ML	Sandy Silt, light brown; some fine sand, little clay, stiff and dense; no fuel observed.
2.7 - 6.5'	SP	Sand Fill, white to light gray; coarse, well sorted; rapid influx of groundwater below 3.7 feet; no fuel observed.
6.5 - 8.0+'	SP	Sand, dark gray; fine to medium, little silt, trace clay; natural sediments; no fuel observed.

BP-8

Location: Steam Plant, in corner of parking lot between plant and tanks, near above-ground pipeline

Depth	Unified Classification	Description
0 - 3.2'	SP	Sand Fill, light brown; fine to medium sand, trace