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Final

Remedial Investigation/Feasibility Study

Appendices
Volume I

Naval Amphibious Base Little Creek
Virginia Beach, Virginia

11/94

Prepared For:

Department of the Navy
Atlantic Division
Naval Facilities
Engineering Command
Norfolk, Virginia

Under the

LANTDIV CLEAN Program

Comprehensive Long-Term
Environmental Action Navy

APPENDIX A

Glossary of Abbreviations

APPENDIX A

List of Acronyms/Abbreviations

Acronym/Abbreviation	Description
ASTM	American Society for Testing and Materials
BHC	benzene hexachloride (Lindane)
BLDG	Building
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CRQL	Contract Required Quantitation Limit
CTO	Contract Task Order
DCA	dichloroethane
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane (Rhothane)
DDE	dimethyldiethyl
DSC	data screening concentration
EGW	existing groundwater monitoring well
EM	electromagnetic
EPA	Environmental Protection Agency
°F	degrees fahrenheit
FS	Feasibility Study
ft	feet/foot

Acronym/Abbreviation	Description
FWEI	Foster Wheeler Enviresponse, Inc.
gpd	gallons per day
gpm	gallons per minute
GPR	ground penetrating radar
GW	groundwater monitoring well
HB	hand boring
I	gradient
IAS	Initial Assessment Study
IP/FP	Implementation Plan/Fee Proposal
K	hydraulic gradient
Koc	soil/sediment partition coefficient
LANTDIV	Atlantic Division
MBCS	Modified Burmister Classification System
MCLs	Maximum Contaminant Levels
mgd	million gallons per day
mi^2	square mile
msl	mean sea level
$\mu g/l$	micrograms/liter (equivalent to ppb)
mg/kg	milligrams/kilogram (equivalent to ppm)
MHz	megahertz
mm	millimeter
mmhos/m	millimhos/meter
MW	monitoring well
N_e	effective porosity
NAB	Naval Amphibious Base

Acronym/Abbreviation	Description
ORA	Oil Reclamation Area
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	perchloroethylene
pH	logarithm of the reciprical of the hydrogen ion concentration of a solution
PID	photoionization device
ppb	parts per billion
PPL	Priority Pollutants List
ppm	parts per million
ppt	parts per thousand
RA	Risk Assessment
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS/RA	Remedial Investigation/Feasibility Study/Remedial Assessment
RMCL	Recommended Maximum Contaminant Level
SARA	Superfund Amendments and Reauthorization Act of 1986
SB	soil boring
SS	surface soil
SVOCs	semi-volatile compounds
SZ	saturated zone
TAL	Target Analyte List
TCA	trichloroethane
TCE	trichloroethene

Acronym/Abbreviation	Description
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
ug/kg	micrograms per kilogram
ug/l	micrograms/liter
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UZ	unsaturated zone
VDWM	Virginia Department of Waste Management
VOAs	volatile organic analytes
VOCs	volatile organic compounds
V_s	flow velocity
VSWCB	Virginia State Water Control Board
WL	watertable level
WQS	Water Quality Standards

APPENDIX A

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Acronym/Abbreviation	Description
ASTM	American Society for Testing and Materials
BHC	benzene hexachloride (Lindane)
BLDG	Building
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CRQL	Contract Required Quantitation Limit
CTO	Contract Task Order
DCA	dichloroethane
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane (Rhothane)
DDE	dimethyldiethyl
DSC	data screening concentration
EGW	existing groundwater monitoring well
EM	electromagnetic
EPA	Environmental Protection Agency
°F	degrees fahrenheit
FS	Feasibility Study
ft	feet/foot
FWEI	Foster Wheeler Enviresponse, Inc.
gpd	gallons per day

Acronym/Abbreviation	Description
gpm	gallons per minute
GPR	ground penetrating radar
GW	groundwater monitoring well
HB	hand boring
I	gradient
IAS	Initial Assessment Study
IP/FP	Implementation Plan/Fee Proposal
K	hydraulic gradient
Koc	soil/sediment partition coefficient
LANTDIV	Atlantic Division
MBCS	Modified Burmister Classification System
MCLs	Maximum Contaminant Levels
mgd	million gallons per day
mi^2	square mile
msl	mean sea level
µg/l	micrograms/liter (equivalent to ppb)
mg/kg	milligrams/kilogram (equivalent to ppm)
MHz	megahertz
mm	millimeter
mmhos/m	millimhos/meter
MW	monitoring well
N_e	effective porosity
NAB	Naval Amphibious Base
ORA	Oil Reclamation Area
PAHs	polyaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCE	perchloroethylene

Acronym/Abbreviation	Description
pH	logarithm of the reciprical of the hydrogen ion concentration of a solution
PID	photoionization device
ppb	parts per billion
PPL	Priority Pollutants List
ppm	parts per million
ppt	parts per thousand
RA	Risk Assessment
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RI/FS/RA	Remedial Investigation/Feasibility Study/Remedial Assessment
RMCL	Recommended Maximum Contaminant Level
SARA	Superfund Amendments and Reauthorization Act of 1986
SB	soil boring
SS	surface soil
SVOCs	semi-volatile compounds
SZ	saturated zone
TAL	Target Analyte List
TCA	trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
ug/kg	micrograms per kilogram
ug/l	micrograms/liter
USCS	Unified Soil Classification System

Acronym/Abbreviation	Description
USEPA	United States Environmental Protection Agency
UZ	unsaturated zone
VDWM	Virginia Department of Waste Management
VOAs	volatile organic analytes
VOCs	volatile organic compounds
V_s	flow velocity
VSWCB	Virginia State Water Control Board
WL	watertable level
WQS	Water Quality Standards

APPENDIX B

Soil and Monitoring Well Boring Logs

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

ORING NO.: 07 - SB - 01 D
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Schmidt / Livingston, NJ

DATE: 7/16/93
LOCATION: Site 7 - 15' N of GW-1
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: ATV Rig / Hollow Stem Auger SIZE/TYPE OF BIT: 4 1/4" ID
SAMPLE METHOD: Continuous split-spoon START/FINISH DATE: 7/15/93 - 7/15/93

WELL INSTALLED? YES___ NO X SCREEN:_____ LENGTH:_____ ___TO___ FEET

REMARKS: Very close to water in Little Creek Cove.

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	01	1.50	5-4-3-3	Top 5" Brown top soil and organics, then light to dark brown VF-F SAND with trace of fines.	-
2-4	02	1.80	3-1-1-0	Top 8" same as bottom of previous spoon, then 4" gray CLAY with some F SAND, then rest gray CLAY with trace F SAND. Last 6" wet.	-
4-6	03	1.00	WOH	Entire spoon gray CLAY with some VF SAND. Wet.	-
6-8	04	1.80	WOH	Entire spoon soft gray CLAY with trace VF SAND.	-
8-10	05	2.00	WOH	Solid gray CLAY with trace VF SAND and trace shell fragments.	-
10-12	06	2.00	WOH	Entire spoon same as last. Shelby tube sample not taken - fell out.	-
12-14	07	2.00	WOH	Entire spoon same as last. Shelby tube sample not taken - fell out.	-
14-16	08	2.00	WOH	Entire spoon solid gray CLAY.	-
16-18	09	2.00	WOH/12-1-1	Same as previous spoon.	-
18-20	10			Shelby tube sample.	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

ORING NO.: 07 - SB - 03 D
ROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Schmidt / Livingston, NJ

DATE: 7/15/93
LOCATION: Site 7 - 10' E of LC7-GW3
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: ATV Rig / Hollow Stem Auger **SIZE/TYPE OF BIT:** 4 1/4" ID
SAMPLE METHOD: Continuous split-spoon **START/FINISH DATE:** 7/15/93 - 7/15/93

WELL INSTALLED? YES ___ **NO** X **SCREEN:** ___ **LENGTH:** ___ ___**TO**___ **FEET**

REMARKS: Sample taken from 4-6' interval. Duplicate sample 07-SB-110(1138).

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	01	1.50	14-14-12-15	Top 4" top soil with organics, then 3" coarse SAND and small GRAVEL, then 9" tan F-M SAND, rest black silty F-M SAND.	-
2-4	02	1.50	9-8-5-7	Top 2" same as bottom of last spoon, then grading into gray to brown CLAY with a trace of F SAND and trace of C SAND. Also, trace of organics.	-
4-6	03	1.60	2-2-2-2	Entire spoon, gray and brown mottled CLAY with trace F SAND and organics. Last 3" wet.	-
6-8	04	2.00	4-5-4-6	Top 2" same as last then grading 3" gray clayey F-M SAND, then grading into tan F-M SAND with trace of fines.	-
8-10	05	1.00	3-4-6-9	Entire spoon, brown clean F-M SAND with trace of fines.	-
10-12	06	2.00	8-10-10-10	Entire spoon same as last.	-
12-14	07	1.70	5-4-4-5	Same as last.	-
14-16	08	2.00	4-4-6-5	Same as last with trace C SAND and trace M GRAVEL.	-
16-18	09	2.00	3-2-5-5	Entire spoon brown F-M SAND with trace of fines and trace C SAND.	-
18-20	10	2.00	3-4-3-2	Entire spoon brown F-M SAND with some fines, trace C SAND and F GRAVEL. Trace of organics. Last 1" some shell fragments.	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

ORING NO.: 07 - SB - 03 D
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Schmidt / Livingston, NJ

DATE: 7/15/93
LOCATION: Site 7 - 10' E of LC7-GW3
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
20-22	11	1.70	3-1-2-2	Top 3" gray and tan mottled CLAY with some F SAND and some shell fragments, then 7" green CLAY with some F SAND, rest gray CLAY with trace F SAND and trace organics.	-
22-24	12	2.00	WOH/18-2	Entire spoon gray CLAY.	-
24-26	13	2.00	1-1-1-1	Same as previous spoon.	-
26-28	14	2.00	3-2-2-1	Entire spoon gray CLAY with trace of shell fragments and VF SAND stringer at 18".	-
28-30	15	2.00	WOH/12-2-1	Entire spoon gray CLAY with trace of shell fragments.	-
30-32	16	2.00	1-2-2-1	Same as last with a 2" lens of gray CLAY with some F SAND at 12".	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

ORING NO.: 07 - SB - 05 D
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Schmidt / Livingston, NJ

DATE: 7/15/93
LOCATION: Site 7 - 200' S of Magazine 14
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: ATV Rig / Hollow Stem Auger **SIZE/TYPE OF BIT:** 4 1/4" ID
SAMPLE METHOD: Continuous split-spoon **START/FINISH DATE:** 7/15/93 - 7/15/93

WELL INSTALLED? YES X **NO**___ **SCREEN:**_____ **LENGTH:**_____ ___**TO**___ **FEET**

REMARKS: Sample taken from 7-9' interval. MS/MSD sample collected

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	01	1.00	2-3-2-2	Top 4" top soil and organics, then 6" gray and brown mottled VF SILTY SAND, rest gray and brown CLAY with some VF SAND.	-
2-4	02	1.00	2-2-2-2	Gray VF SILTY SAND with large amount of organics. Bottom 3" wood/root - like material. Last 6" damp.	-
4-6	03	0.80	2-2-2-3	Brown and gray mottled CLAY with some VF SAND and some organics.	-
6-8	04	1.50	3-4-5-4	Top 6" brown and gray mottled CLAY with some organics, then brown and gray mottled VF SANDY CLAY with trace of organics.	-
8-10	05	1.70	2-2-4-2	Top 2" gray CLAY with some organics and trace VF SAND, then 1" red CLAY with trace VF SAND, then gray and brown mottled VF SANDY CLAY grading into a F-M SILTY SAND. Last 6" wet.	-
10-12	06	2.00	3-6-7-7	Top 2" same as bottom of last spoon, then 2" F-C SILTY SAND, then F-M SAND with trace fines.	-
12-14	07	1.20	2-3-5-6	Top 6" brown F-M SAND with trace fines grading into clean F-M SAND.	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 07 - SB - 105 D
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Schmidt / Livingston, NJ

DATE: 7/15/93
LOCATION: Site 7 - 200' S of Magazine 14
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
14-16	08	2.00	4-7-8-10	Entire spoon F SAND with trace of fines.	-
16-18	09	2.00	2-4-8-8	Top 18" same as above, then brownish reddish VF-F SAND with some fines and 1/8" thick gray CLAY lenses every 1".	-
18-20	10	2.00	4-6-5-4	Top 10" VF-F SAND with trace C SAND and some fines grading into red/brown VF SILTY SAND.	-
20-22	11	2.00	3-3-4-4	Top 1" brown/red VF-F SAND with some fines, then rest gray and brown mottled CLAY with some F-M SAND.	-
22-24	12	2.00	2-3-4-4	Top 1.5' washed-in sand, then rest gray and brown mottled CLAY with trace F SAND.	-
24-26	13	2.00	3-4-5-5	Entire spoon gray and brown mottled CLAY with trace F SAND.	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 07 - SB - 06 D
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Evans / Livingston, NJ

DATE: 7/14/93
LOCATION: Site 7 - Sanitary Landfill
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: ATV Rig / Hollow Stem Auger
SIZE/TYPE OF BIT: 4 1/4" ID
SAMPLE METHOD: Continuous split-spoon
START/FINISH DATE: 7/14/93 - 7/14/93

WELL INSTALLED? YES___ NO_X_ SCREEN:_____ LENGTH:_____ ___TO___ FEET

REMARKS:_____

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	01	1.58	2-3-4-5	Grass, roots, M-F dry, loose, moderately well sorted brown SAND. Trace CLAY.	-
2-4	02	1.41	5-5-5-4	Tan M-F dry moderately well sorted SAND. Some shell fragments. Lower 2" trace damp.	-
4-6	03	1.58	2-1-1-0	Top 5" brown trace damp M-F SAND. 11" light brown, moist M-F SAND.	-
6-8	04	1.41	2-1-1-2	Upper 2" tan M-F SAND with a trace of silt, moist. At 2" pine needle layer, then orangish brown bands of VF SAND with some silt. Next 3" F-VF SAND with a trace of silt, saturated. Lower 10" wet gray F-VF SAND with a trace of silt. Bottom 5" saturated.	-
8-10	05	1.58	1-1-0-1	Top 5" brown orange mottled M-F SAND. Moist, wood fragments. Lower 14" wet gray F-VF SAND with a trace of silty clay.	-
10-12	06	1.16	5-2-3-4	Top 3", slough, brown, dry M-F SAND, next 2" gray M-F SAND with trace silty clay. Lower 9" light gray loose M-F SAND. Very little silt.	-
12-14	07	1.33	4-4-4-5	Top 4" VF SAND with some silt. Next 6" saturated gray loose moderately sorted M-F SAND. Lower 6" graduated to tan loose moderately sorted M-F SAND.	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 07 - SB - 06 D
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Evans / Livingston, NJ

DATE: 7/14/93
LOCATION: Site 7 - Sanitary Landfill
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
14-16	08	1.75	4-4-7-6	Top 3" slough. Lower 18" moderately sorted tan, wet M-VF SAND with a trace of silt.	-
16-18	09	2.00	4-5-5-6	Top 10" gray saturated moderately sorted M-F SAND, trace C sand, very little fines. Lower 14" tan saturated moderately sorted M-VF SAND.	-
18-20	10	2.00	2-2-2-2	Top 4" slough. Orange moderately sorted M-F SAND. Lower 20" light gray soft CLAY with occasional orangish mottles. Sand lenses at 13", trace F-VF SANDY SILT.	-
20-22	11	2.00	3-3-3-3	Top 5" brown to tan M-F SAND. Lower 19" very soft gray CLAY with orange mottles. Trace M-F orange SAND.	-
22-24	12	1.91	2-2-3-3	Top 1" slough. Remainder gray soft CLAY mottled yellowish brown. Occasional peat lenses at lower 9".	-
24-26	13	2.00	4-4-4-4	Soft to medium firm gray CLAY with some orangish brown peat lenses.	-
26-28	14	2.00	3-4-5-6	SAME as previous spoon.	-
28-30	15	2.00	5-5-5-6	SAME as previous spoon.	-
30-32	16	2.00	5-5-5-2	Top 3" slough, very soft gray CLAY with some M-F silty sand. Remaining 21" firm gray CLAY with orange and brown mottles.	-
32-34	17	2.00	7-11-12-11	Top 13" gray soft CLAY. Remainder tan M-F SANDY CLAY, with some iron concretions.	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 07 - SB - 06 D
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Evans / Livingston, NJ

DATE: 7/14/93
LOCATION: Site 7 - Sanitary Landfill
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
34-36	18	2.00	5-6-7-9	Top 6" slough, saturated light brown poorly sorted VC-M SAND. Lower 18" light gray CLAY with tan mottles. Trace of brown M-F SAND stringers.	-
36-38	19	2.00	5-5-5-7	Top 8" saturated slough, poorly sorted C-M SAND. Remainder firm gray CLAY with orangish brown mottles.	-
38-40	20	2.00	5-7-7-5	Top 13.5" slough, saturated brown poorly sorted C-F SAND. Remainder firm greenish gray CLAY.	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

`ORING NO.: 07 - SB - 09 D
ROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Schmidt / Livingston, NJ

DATE: 7/13/93
LOCATION: Site 7 - Sanitary Landfill
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: ATV Rig / Hollow Stem Auger SIZE/TYPE OF BIT: 4 1/4" ID
SAMPLE METHOD: Continuous split-spoon START/FINISH DATE: 7/13/93 - 7/13/93

WELL INSTALLED? YES___ NO_X_ SCREEN:_____ LENGTH:_____ ___TO___ FEET

REMARKS:_____

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	01	1.00	2-1-2-2	Top 1" brown top soil, then brown and gray F SILTY SAND, then gray silty F-M SAND. Trace of M-C sand.	-
2-4	02	1.50	3-5-3-3	Entire spoon brown to gray silty F-M SAND. Change to F-VF SAND at 1'. Brown, less fines last 6".	-
4-6	03	None	WOH	Trace of F-VF SAND but most washed out.	-
6-8	04	1/2"	WOH	Gray VF SAND with some silt.	-
8-10	05	1.10	WOH	Top 1" fall-in, then 9" gray CLAY with trace of VF SAND, then rest same with little F sand.	-
10-12	06	1.50	1-0-1-0	Top 3" gray CLAY with a lot of F sand, then gray CLAY with a trace F sand and trace organics.	-
12-14	07	1.00	WOH	Top 3" gray CLAY with some F SAND and trace of organics, then rest grey CLAY with some F SAND.	-
14-16	08	2.00	WOH	Alternating 2-3" thick bands of gray CLAY with some F SAND and gray SAND with some silt.	-
16-18	09	2.00	WOH	Top 6" gray CLAY with trace VF SAND and trace organics, then 1' solid dry gray CLAY, then last 6" same as first 6".	-
18-20	10	2.00	WOH	Solid gray CLAY, dry.	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 07 - SB - 09 D
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Schmidt / Livingston, NJ

DATE: 7/13/93
LOCATION: Site 7 - Sanitary Landfill
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
20-22	11	2.00	WOH/12-1-1	Same as previous spoon.	-
22-24	12	2.00	WOH	Same as previous spoon, but with the F SAND stringers at 1' and 18".	-
24-26	13	2.00	WOH/12-1-1	Entire spoon gray CLAY with a shell at 14".	-
26-28	14	2.00	WOH/12-2-1	Entire spoon gray CLAY with some F SAND.	-
28-30	15	2.00	WOH	Entire spoon gray CLAY with traces F SAND and occasional F SAND stringers.	-
30-32	16	2.00	3-2-2-1	Top 18" gray CLAY with trace of F SAND and occasional F SAND stringers, then two 2" wood segments with gray CLAY with some F SAND.	-
32-34	17	2.00	WOH	Top 8" gray CLAY, then gray CLAY with some F SAND and some organics.	-
34-36	18	2.00	WOH/18"-3	Top 20" gray F SANDY CLAY with trace of organics, then dark grey F SANDY CLAY.	-
36-38	19	2.00	WOH	Top 18" dark gray F SANDY CLAY, then 2" gray CLAY with some F SAND, then 2" gray F SANDY CLAY, then 2" light gray CLAY with some F SAND.	
38-40	20	2.00	3-4-4-4	Entire spoon mottled green and brown clay.	-

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 12 - SB - 01
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Schmidt / Livingston, NJ

DATE: 5/24/93
LOCATION: Site 12
DRILLING CONTRACTOR: McCallum Testing,Inc.
DRILLER: Raleigh Smith III

DRILLING EQUIPMENT/METHOD: Mobile B-61 / Hollow Stem Auger **SIZE/TYPE OF BIT:** 4 1/4 inch
SAMPLE METHOD: Continuous split-spoon **START/FINISH DATE:** 5/24/93 - 5/24/93

WELL INSTALLED? YES X **NO** ___ **SCREEN:** 0.10 **LENGTH:** 10' 3 **TO** 13 **FEET**

REMARKS: No HNu readings, augered to 13'.

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	SS-1	1.60	6-5-16-23	Top 4", brown F SANDY CLAY with some F-M GRAVEL, then brown CLAY with some F SAND. Last 1" dark brown CLAY with M GRAVEL.	
2-4	SS-2	1.20	9-9-10-11	Entire spoon, brown CLAY with trace of F SAND.	
4-6	SS-3	1.60	4-5-7-10	Top 4" brown and grey mottled F SANDY CLAY grading into poorly sorted F-C SAND. Last 2" Wet.	
6-8	SS-4	1.40	7-9-10-10	Top 6" same as above last, then grading into 3" brown silty F-C SAND with trace of fines, wet.	
8-10	SS-5	1.30	5-7-7-10	Entire spoon, light brown F-M SAND, wet.	
10-12	SS-6	1.90	7-10-14-15	Same as above.	

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 12 - SB - 02
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: D. Place / Livingston, NJ

DATE: 5/24/93
LOCATION: Site 12
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: Aker AD-2 / Hollow Stem Auger SIZE/TYPE OF BIT: 4 1/4 inch
SAMPLE METHOD: Continuous split-spoon START/FINISH DATE: 5/24/93 - 5/24/93

WELL INSTALLED? YES X NO___ SCREEN: 0.10 LENGTH: 10' 3 TO 13 FEET

REMARKS: Both HNus inoperable.

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	SS-1	0.9	3-2-1-2	Top 0.3' sandy loam M-F SAND with little gravel, traces of clay and silt - tan.	
2-4	SS-2	1.20	2-2-1-2	M-F SAND with little gravel and clay, trace silt, tan. Clay lens at 1.0' in spoon.	
4-6	SS-3	1.50	2-3-4-4	Wet to moist (Wet at bottom). Top 0.4' SANDY CLAY with traces of silt and gravel. Bottom M-F SAND with little gravel, some clay. Trace silt, wet.	
6-8	SS-4	1.70	4-2-3-5	Top 0.5' same as above. Middle 0.7', same, mixed with black silt and organics. Bottom 0.5' C-F SAND - clean, trace of fines, wet, light brown.	
8-10	SS-5	1.70	3-2-3-4	Top 0.4', CLAY with trace of sand. Bottom 1.3' M-C SAND, with trace of silt and gravel, light brown.	
10-12	SS-6	1.90	5-7-9-11	Same as above.	
12-14	SS-7	1.90	6-10-11-10	Same as above.	

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 12 - MW - 03
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: M. Schmidt / Livingston, NJ

DATE: 5/24/93
LOCATION: Site 12 - W Side of Bldg, N Wall
DRILLING CONTRACTOR: McCallum Testing,Inc.
DRILLER: Raleigh Smith III

DRILLING EQUIPMENT/METHOD: Mobile B-61 / Hollow Stem Auger **SIZE/TYPE OF BIT:** 4 1/4 inch
SAMPLE METHOD: Continuous split-spoon **START/FINISH DATE:** 5/24/93 - 5/24/93

WELL INSTALLED? YES X **NO** ___ **SCREEN:** 0.10 **LENGTH:** 10' 2 **TO** 12 **FEET**

REMARKS: No HNu.

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	SS-1	1.90	4-6-7-6	Top 3", top soil with organics, then 2" light brown F SANDY CLAY with M-GRAVEL, then 4" brown silty CLAY, then brown CLAY.	
2-4	SS-2	1.60	8-8-7-7	Top half of spoon, light brown silty CLAY, grading into gray and brown mottled CLAY with trace of fines.	
4-6	SS-3	1.80	4-6-7-8	Top 4" same as last, then brown and grey F-M SAND with trace C SAND. Last 1" wet.	
6-8	SS-4	1.50	10-8-8-9	Entire spoon, light brown F- SAND with some fines, wet.	
8-10	SS-5	1.80	5-7-7-10	Top 4" same as last, then grading into F-M SAND with some fines and trace of C SAND, wet.	
10-12	SS-6	2.0	6-8-10-12	Entire spoon, F-M SAND with trace of fines and trace of C SAND, wet.	

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 12 - SB - 04
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: D. Place / Livingston, NJ

DATE: 5/24/93
LOCATION: Site 12 - Along Canal by road.
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: Mobile B-61 / Hollow Stem Auger SIZE/TYPE OF BIT: 3 1/4 inch
SAMPLE METHOD: Continuous split-spoon START/FINISH DATE: 5/24/93 - 5/24/93

WELL INSTALLED? YES X NO___ SCREEN: 0.10 LENGTH: 10' 2 TO 12 FEET

REMARKS: MW - 4 location. HNus both inoperable.

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	SS-1	1.50	30-28-10-17	C-F SAND with little gravel, trace of fines. Middle, hard packed C-F SAND with some clay. Tan to reddish brown. Bottom 0.6 CLAY, some F SAND, brown and mottled.	
2-4	SS-2	1.60	14-12-13-13	F SAND, little clay and trace of silt. Stringers of C SAND, brown to tan.	
4-6	SS-3	1.80	7-8-8-11	Top 0.4' same as above. Middle 0.3' C-F SAND, traces of gravel and fines. Next 0.2' - clean, white C-F SAND. Bottom 0.9' C-F SAND, brown, trace of fines, grading into F SAND.	
6-8	SS-4	1.90	10-11-4-2	Top 0.7' C-F SAND, traces of silt and clay. Bottom 1.2', F SAND, trace of fines. Both tan to brown.	
8-10	SS-5	1.80	4-7-7-8	C-F SAND, with Trace of fines and gravel, light brown.	
10-12	SS-6	1.9	4-8-9-9	Same as above, with shell fragments.	

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

BORING NO.: 13 - SB - 06
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: D. Place / Livingston, NJ

DATE: 6/28/93
LOCATION: Site 13 - By storage area.
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: Mobile B-61 / Hollow Stem Auger
SIZE/TYPE OF BIT: 4 1/4 inch
SAMPLE METHOD: Continuous split-spoon
START/FINISH DATE: 6/28/93 - 6/28/93

WELL INSTALLED? YES X NO___ SCREEN: 0.10 LENGTH: 10' 3 TO 13 FEET

REMARKS: Well 13-GW-6.

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	SS-1	1.20	3-7-6-6	Top 0.5' M-F SAND with some gravel, bottom 0.7' brown mottled CLAY, with trace of silt and F SAND.	
2-4	SS-2	1.40	6-7-8-9	Same, grading into tan CLAY, tip wet.	1.0
4-6	SS-3	1.80	7-4-2-2	Top 0.4' same. Middle 1.0' M-F SAND, well-sorted. Bottom 0.3' CLAY, little sand and silt, reddish brown.	
6-8	SS-4	1.90	10-8-8-12	Top 0.2' same. Bottom 1.7' C-F SAND, reddish brown, traces of gravel and silt. Whole spoon wet.	
8-10	SS-5	2.00	5-6-6-7	Top 0.4' VF-F SAND, little to some clay and silt. Bottom 1.6' reddish brown, clean M-F SAND, very well sorted.	
10-12	SS-6	1.80	5-5-6-8	Same as above.	

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

'ORING NO.: 13 - SB - 07
ROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: D. Place / Livingston, NJ

DATE: 6/28/93
LOCATION: Site 13
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: Mobile B-61 / Hollow Stem Auger SIZE/TYPE OF BIT: 4 1/4 inch
SAMPLE METHOD: Continuous split-spoon START/FINISH DATE: 6/28/93 - 6/28/93

WELL INSTALLED? YES X NO___ SCREEN: 0.10 LENGTH: 10' 3 TO 13 FEET

REMARKS: Well GW-7

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	SS-1	0.9	4-3	Augered through asphalt top 0.2', then gravel with C-F SAND to 1.0'. Some road bed crushed stone. Bottom 0.9', reddish brown, mottled CLAY, trace of silt and sand.	
2-4	SS-2	1.80	2-2-2-2	Same - lighter color, tip moist.	
4-6	SS-3	2.00	2-1-3-8	Top 1.8 ' same. Bottom 0.2' C-F SAND, very clean and well sorted - wet spoon.	
6-8	SS-4	1.70	7-13-13-17	C-M SAND, clean well sorted, wet.	
8-10	SS-5	1.80	7-6-9-9	Reddish brown, C-F SAND, trace of red clay.	
10-12	SS-6	2.00	6-6-8-10	Top 1.8' same as above with stratification of biotite grains. Bottom 0.2' F SAND tan to white, trace of clay.	
12-14	SS-7	1.80	4-6-2-4	Top 0.5' M-F SAND, trace of clay. Next 0.5' F SAND, trace of clay. Bottom 0.8', same with some clay.	

FOSTER WHEELER ENVIRONMENTAL SERVICES
TEST BORING LOG

)RING NO.: 13 - SB - 08
PROJECT NO./NAME: 4-22-00-192071 / NAB - Little Creek
GEOLOGIST/OFFICE: D. Place / Livingston, NJ

DATE: 6/28/93
LOCATION: Site 13
DRILLING CONTRACTOR: McCallum, Inc.
DRILLER: Tom Jones

DRILLING EQUIPMENT/METHOD: Mobile B-61 / Hollow Stem Auger **SIZE/TYPE OF BIT:** 4 1/4 inch
SAMPLE METHOD: Continuous split-spoon **START/FINISH DATE:** 6/28/93 - 6/28/93

WELL INSTALLED? YES X **NO** ___ **SCREEN:** 0.10 **LENGTH:** 10' 2.5 **TO** 12.5 **FEET**

REMARKS: Well GW-8

DEPTH (FT)	SAMPLE NO. AND TYPE	RECOVERY (FT)	PENETRATION RESISTANCE BLOWS/6"	SAMPLE DESCRIPTION	PID READING (PPM)
0-2	SS-1	1.4	14-13-14-14	Top 0.5' GRAVEL with C-F sand and clay, slight odor. Bottom 0.9' black CLAY with little sand and silt.	15.0
2-4	SS-2	0.80	4-3-6-4	Top 0.4' gray CLAY, trace of sand and silt. Bottom 1.0' reddish brown CLAY.	1.0
4-6	SS-3	1.40	4-3-3-3	Top 0.5' dark brown CLAY and GRAVEL. Bottom 0.7' F SAND. Tip wet.	3.0
6-8	SS-4	0	2-2-4-6	Top 1.2' CLAY, reddish brown, traces of silt and F SAND. Bottom 0.6' C-M SAND, well-sorted, gray. Strong odor.	20.0
8-10	SS-5	0.70	4-5-7-8	Top 0.5' dark gray CLAY, trace of sand and silt. Bottom C-M SAND, reddish brown, well-sorted.	3.0
10-12	SS-6	1.30	5-7-9-11	Top 0.8'- C-F SAND, traces of silt and clay, tan to gray. Bottom 1.2' C-F SAND, reddish brown.	
12-14	SS-7	1.80	4-6-3-7	Top 1.4', same. Bottom 0.4' F SAND, gray, well-sorted.	

Existing well logs available for use with this RI.

PROJECT NUMBER	BORING NUMBER	
W2036B	LC7-GW1	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 5.70 DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 5', 4/18/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
		0-2	S1	1.8	3-4-4-4	F-M sand w/some clay; yel. brown (10YR5/4)-yel. orange(10YR6/6) dry-moist		GROUT; BENTONITE
	5	4-6	S2	2.0	1-0-0-0			SAND
	10	9-11	S3	2.0	1-0-0-0	Clay; gr. black(5GY2/1); soft; sicky; wet shell fragments at 9'		
	15	14-16	S4	2.0	1-0-0-0			
	20							

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W20368	LC7-GW2	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 9.97' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 5', 4/17/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION
		0-2	S1	1.4	2-5-14-14			2 inch PVC; GROUT
	5	4-6	S2	1.4	7-7-6-9	F-C sand; yell. brown(10YR5/4) -pale yel(10YR6/2); some occasional clay; wet		BENTONITE
	10	9-11	S3	1.4	1-3-3-3			SAND
	15	14-16	S4	2.0	2-4-4-6			
						F-M sand; w/some silt; yel. brown(10YR5/4)		
	20	19-21	S5	1.7	3-3-5-8			
						As above, but with shell fragments.		
	25							

PROJECT NUMBER	BORING NUMBER	
W20368	LC7-GW3	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 10.27' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 5', 4/17/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION (2 inch PVC)
		0-2	S1	1.4	7-5-12-14	F-sand w/some gravel; br. black (5YR2/1); sl. moist		GROUT
	5	4-6	S2	2.0	3-3-3-3	Fine sandy clay; olive gr(5Y4/1)-yel brown(10YR4/2); wet at 5'		BENTONITI
	10	9-11	S3	1.8	3-4-5-8	F-M sand w/some c. sand and clay; yel. orange(10YR6/6); wet		SAND
	15	14-16	S4	2.0	3-4-7-9			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC7-GW4	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 6.69' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 2', 4/21/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: .2 inch PVC
		0-2	S1	1.4	7-5-4-7	F-M sand w/clay patches; yel. brown (10YR5/4)-olive gray(5Y61); some shell fragments at 5'		GROUT; BENTONIT
	5	4-6	S2	2.0	2-5-8-10			SAND
	10	9-11	S3	1.6	2-3-1-1	Fine silty sand; gray(N5)-olive gray(5Y5/2); shell fragments.		
	15	14-16	S4	1.7	2-3-1-0			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC7-GW5	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 6.84' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 4', 4/17/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION (2 inch PVC)
		0-1.5	S1	12	1-1-1	Clayey sand; gray(N5)-yel. brown(10YR5/4); moist, sl. plastic; sl. sticky		GROUT
						Fine silty sand; gray(N4), wet some roots		
	5	3.5-5	S2	8	1-2-3			BENTONITE
						Sandy clay; gray(N3)-gr. gray(5G6/1); soft to sl. plastic; wet		
	10	8.5-10	S3	1	1-2-0	Root blocking spoon at 8.5'		SAND
	15	13.5-15	S4	14	2-3-5	F-C sand w/some gravel; gray(N5); wet		
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC7-GW6	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 6.74' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 5', 4/21/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION (2 inch PVC)
		0-1.5	S1	17	1-2-2	F-M sand w/clay in layers; gray(N4) - brown(10YR5/4) moist-wet		GROUT
	5	3.5-5	S2	12	2-2-1			BENTONIT
	10	8.5-10	S3	15	2-2-3	F-M sand w/some f. gravel; gr. gray(5GY6/1)-yel. orange (10YR6/6); wet; some recent shell fragments (not typical Yorktown formation)		SAND
	15	13.5-15	S4	18	3-4-5			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC7-GW7	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 1.96' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 2', 4/22/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
		0-1.5	S1	16	1-1-2	F-C sand; gray(N4-N6); roots; wet		GROUT
								BENTONITE
	5	3.5-5	S2	0	1-0-0	Clay w/some silt and sand; gray(N4); very fluid at 3-5'; sticky; sl. plastic elsewhere; wet		SAND
	10	8.5-10	S3	13	1-0-0			
	15	13.5-15	S4	10	1-0-0			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC7-GW8	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 2.25' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 2', 4/22/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION
		0-1.5	S1	13	2-0-1	F-M sand; gray(N6-N4); roots; wet; clay at bottom		2 inch PVC; GROUT; BENTONITE
	5	3.5-5	S2	24	1-0-0	Silty clay w/some sand; v. soft-sl. soft, sl. sticky; gr. gray(5GY4/1)		SAND
	10	8.5-10	S3	24	1-0-0			
	15							

PROJECT NUMBER	BORING NUMBER	
W20368	LC9-GW1	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 7.62' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 4', 4/28/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	WELL CONSTRUCTION (2 inch PVC)
	5	4-6	S1	1.4	2-3-5-5	F-M sand; yel. brown (10YR6/2); wet at 4'		GROUT; BENTONITE; SAND
	10	9-11	S2	2.0	0-0-2-2			
	15	14-16	S3	2.0	0-1-1-1	Fine sand w/some clay; ol. gray(5Y4/1)		
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC9-GW2	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 6.42' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 4', 4/28/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
	5	4-6	S1	1.5	3-5-5-9	F-M sand; yellow, orange (10YR6/6); olive gray(5Y6/1) at 9"; wet at 4'		GROUT; BENTONITE
	10	9-11	S2	2.0	3-4-4-2			SAND
	15	14-16	S3	2.0	0-1-1-3	Fine sand and clay;olive/gray(5Y4/1);we		
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC9-GW3	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 7.86' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 5', 4/25/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
	5	4-6	S1	1.1	1-1-3-1	F-M sand; roots and wood to 5'; br. gray(5YR4/1)-olive black (5Y2/1)		GROUT; BENTONITE
	10	9-11	S2	2.0	3-5-12-13			SAND
	15	14-16	S3	2.0	1-2-4-7			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC9-GW4	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 8.45' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 6', 4/22/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
		0-2	S1	1.6	2-8-8-10	Fine sandy clay; yel. brown(10YR5/4); dry		GROUT
	5	4-6	S2	1.6	2-5-6-8	F-M sand w/some silt; yel. brown (10YR6/2); moist-wet		BENTONITE
						Fine sandy clay; brown black(5YR2/1); wet; roots		
	10	9-11	S3	2.0	3-4-6-8	F-M sand w/some silt and c. sand; yell. brown(10YR4/2)-olivegray (5Y4/1); roots, wood.		SAND
	15	14-16	S4	2.0	2-2-2-1			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC9-GW5	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

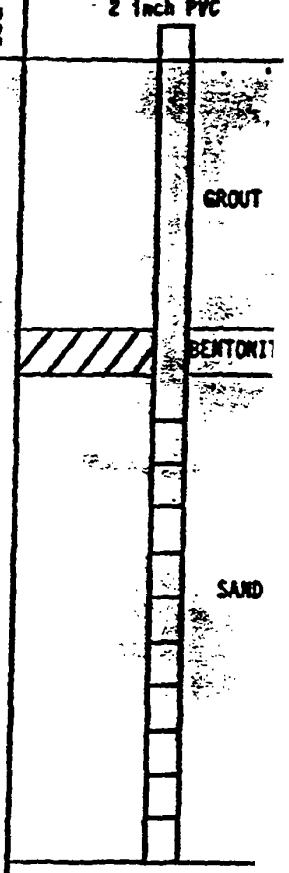
ELEVATION 10.59' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 8' 4/29/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG
	5	3.5-5	S1	14	3-5-8	F-C sand; pale orange(10YR8/2)-yel. orange(10YR8/6); wet at 8'	
	10	8.5-10	S2	11	3-2-3		
	15	13.5-15	S3	11	5-7-7	F-M sand; gray(N5), wet	
	20	18.5-20	S4	18	1-1-0	Sandy clay; gr. gray(5G4/1); sl. plastic sl. sticky	

WELL CONSTRUCTION



PROJECT NUMBER	BORING NUMBER	
W20368	LC9-GW6	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 5.68' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 3', 4/29/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: .2 inch PVC
		3.5-5	S1	15	3-5-7	F-M sand w/some f. gravel; gray(N7)-gr. gray(5G6/1); wet		GROUT; BENTONITE; SAND
	5							
		8.5-10	S2	16	2-4-2			
	10							
		13.5-15	S3	24	1-1-1	Sandy clay; gr.gray(5G4/1); sl. plastic, sl. sticky		
	15							
	20							

Site 9

SOIL BORING MW #1
DATE DRILLED 9/30/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Building #3699
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0						Asphalt, Crushed Stone Base.
					SP	Brown medium sand. Petro Odor.
5					SP	Tan medium sand
10						
15						

METHOD OF DRILLING: Hollow Stem Drilling
HOLE DIAMETER: 12 inches
END OF BORING: 17 feet
WELL DIAMETER: 4 inches
WELL MATERIAL: PVC
SAMPLING METHOD: Split Spoon

SOIL BORING MW #2
DATE DRILLED 9/30/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Building #3699
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0					SC	Black clay w/ some sand.
5		5 3 2				
					SP	Black medium sand.
10		15 15 11				
					SP	Gray medium sand.
15		5 1 3				

METHOD OF DRILLING: Hollow Stem Drilling
HOLE DIAMETER: 12 inches
END OF BORING: 16 feet
WELL DIAMETER: 4 inches
WELL MATERIAL: PVC
SAMPLING METHOD: Split Spoon

SOIL BORING MW #3
DATE DRILLED 9/30/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Building #3699
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 25 50	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0					SC	Brown medium sand w/ clay. Wood debris present.
5		5 4 9				
					SP	Gray medium sand. Wood debris present. Slight solvent odor. PID readings of wood debris = 400 ppm.
10		8 12 13				
					SC	Gray medium sand w/ some clay.
15		5 2 2				

METHOD OF DRILLING: Hollow Stem Drilling
HOLE DIAMETER: 12 inches
END OF BORING: 16 feet
WELL DIAMETER: 4 inches
WELL MATERIAL: PVC
SAMPLING METHOD: Split Spoon

SOIL BORING MW #4
DATE DRILLED 9/30/91
CLIENT PRC Inc.
PROJECT NAB Little Creek
LOCATION Building #3699
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0					SP	Tan medium sand.
5		2 2 1				
10		2 2 7				
					SP	Gray medium-fine sand.
15		6 3 3				

METHOD OF DRILLING: Hollow Stem Drilling
HOLE DIAMETER: 12 inches
END OF BORING: 16 feet
WELL DIAMETER: 4 inches
WELL MATERIAL: PVC
SAMPLING METHOD: Split Spoon

... 2 clay lenses ...

1,247
71

PROJECT NUMBER	BORING NUMBER	
W20368	LC10-GW1	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 14.85' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 10', 4/28/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
	5	3.5-5	S1	14	6-7-10	F-M sand; gray-orange (10YR7/4)-gray(N3,N7); moist		GROUT
								BENTONITE
	10	8.5-10	S2	16	5-7-9			
						As above; gr. gray(5GY4/1); occasional clay lenses; wet		SAND
	15	13.5-15	S3	15	5-6-7			
	20	18.5-20	S4	6	6-7-7			

PROJECT NUMBER	BORING NUMBER	
W20368	LC10-GW2	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 12.16' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 8', 4/24/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION
	5	3.5-5	S1	16	3-9-8	F-M sand w/some clay lenses; yel. orange(10YR6/6) - yel. brown(10YR5/4); moist		2 inch PVC; GROUT; BENTONITE
		8.5-10	S2	13	1-1-0			
	10					F-C clayey sand; gray green (5GY4/1); occasional clay lenses, sl plastic, sl. sticky; wet		SAND
		13.5-15	S3	15	4-5-6			
	15							
		18.5-20	S4	15	2-2-3			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC10-GW3	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 10.43' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 8', 4/28/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
		3.5-5	S1	15	4-6-6	F-M sand; pale orange(10YR8/2)-gray(N7), dry-moist		GROUT
	5							BENTONIT
		8.5-10	S2	11	4-5-7	F-M sand; olive gray(5Y6/1)-gr. gray(5GY4/1); wet		SAND
	10							
		13.5-15	S3	13	3-3-4			
	15					Sandy clay and clayey sand; gray green(5GY4/1); plastic, sl. sticky, wet		
		18.5-20	S4	24	1-1-2			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC10-GW4	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 11.23' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 4/24/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION
	5	4-6	S1	1.5	4-6-4-9	F-M sand; pale orange(10YR6/2)-yel. brown(10YR5/4); moist-wet; occasional sandy clay patches.		GROUT; BENTONITE
	10	9-11	S2	1.6	3-5-6-6	F-M sand; gray(N5); wet		SAND
	15	14-16	S3	2.0	0-1-3-4	Clay w/some sand at 16'; olive black (5Y2/1); soft, sticky, plastic		
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC10-GW5	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 10.69' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 8', 4/24/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION (NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL)	SYMBOLIC LOG	WELL CONSTRUCTION (2 inch PVC)
	5	3.5-5	S1	16	4-5-9	F-M sand; yel. orange(10YR6/6)-yel. brown(10YR5/4); moist		GROUT; BENTONIT
	10	8.5-10	S2	13	4-3-2	As above; gray(N5); wet		
						Silty clay; gr. black(5GY2/1); sl. sticky, plastic, shell fragments		SAND
	15	13.5-15	S3	18	4-4-7	F-C sand; gr. gray(5GY4/1); wet		
	20	18.5-20	S4	18	4-4-2			

PROJECT NUMBER	BORING NUMBER	
N20368	LC10-GW6	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

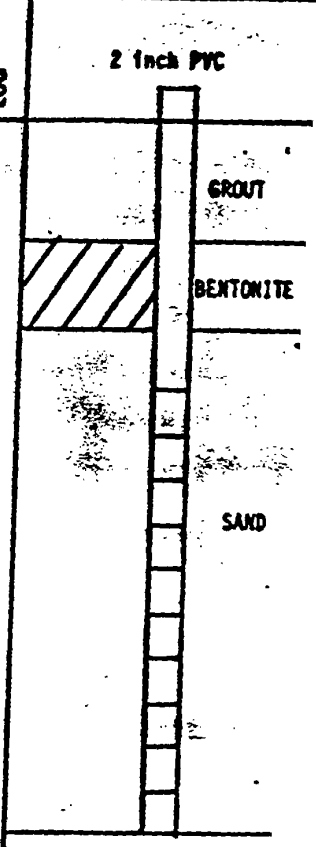
ELEVATION 9.28' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 7', 4/24/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG
	5	4-6	S1	1.6	2-3-5-3	F-M sand; pale orange(10YR8/2)-olive gray(5Y4/1): moist-wet
	10	9-11	S2	1.4	2-6-3-3	F-C sand; black; wood, glass, brick, sludge
						F-M sand; gray(N6-N5)
	15	14-16	S3	1.3	7-1-1-1	Sandy clay; olive gray(5Y4/1);soft, sticky
	20					

WELL CONSTRUCTION



PROJECT NUMBER	BORING NUMBER	
W20368	LC10-GW7	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 10.67' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 4/23/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION
						F-M sand; yel. brown(10YR5/4); v. moist at 5'		2 inch PVC; GROUT; BENTONITE
	5	4-6	S1	1.7	5-5-9-10	F-C sand; br. black; wood, glass, ash		
	10	9-11	S2	1.6	2-2-5-5	F-M sand w/some patches of clay; l. olive gray(5Y4/1); wet		SAND
	15	14-16	S3	1.6	4-5-7-8			
	20	19-21	S4	1.7	4-2-3-4	As above; l. brown(5YR5/6)-gr. orange		
	25							

PROJECT NUMBER	BORING NUMBER	
W20368	LC11-GW1	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 8.75' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 8', 4/30/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
		0-1.5	S1	14	5-6-12	sand-silt; yel. brown(10YR4/2)-pale orange(10YR8/2), dry, hard		
						Sandy clay; yel. orange(10YR6/6); sl. plastic; moist		GROUT
	5	3.5-5	S2	16	2-3-2			BENTONIT
	10	8.5-10	S3	17	7-7-9	F-M sand; yel. orange (10YR6/6); wet		SAND
	15	13.5-15	S4	15	6-9-9			
	20	18.5-20	S5	18	1-1-1	Sandy clay; gray(N4); sl.plastic, sl. sticky		

PROJECT NUMBER	BORING NUMBER	
W20368	LC11-GW2	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 7.56' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 8', 5/1/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
		3.5-5	S1	14	2-2-1	Sandy silt and sandy clay; yel. brown (10YR4/2)-yel. orange (10YR6/6); moist, stiff, sl. plastic		GROUT; BENTONITE
	5							
								SAND
			S2	14	7-11-12	F-M sand w/some f. gravel; yel. orange(10YR6/6); black specs in sand; wet		
	10	8.5-10						
		13.5-15	S3	18	5-7-12			
	15							
		18.5-20	S4	18	5-6-4			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC11-GW3	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 7.40' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 8', 5/1/86 START FINISH LOGGER DRONFIELD

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (IN)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY; PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION 2 inch PVC
		3.5-5	S1	17	2-2-2	Sandy clay; gray(N6)-yel. orange(10YR6/6); sl. plastic, stiff, moist		GROUT
	5							BENTONIT
		8.5-10	S2	15	6-9-10	F-M sand; yel. orange (10YR8/6); some black specs in sand; coarse sand at 19', wet		SAND
	10							
		13.5-15	S3	18	6-8-13			
	15							
		18.5-20	S4	16	4-4-5			
	20							

PROJECT NUMBER	BORING NUMBER	
M20368	LC13-GM1	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 7.49' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 4/30/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
	5	4-6	S1	1.8	3-2-7-10	F-M sand; tr. clay and gravel; yel. orange(10YR6/6)-yel. brown(10YR6/2); wet at 5'		GROUT; BENTONIT
	10	9-11	S2	2.0	5-4-4-2			SAND
	15	14-16	S3	2.0	3-3-2-4			
	20	19-21	S4	2.0	2-2-2-2	Clay; gray(N4) - olive gray(5Y4/1); oyster shell fragments		
	25							

PROJECT NUMBER	BORING NUMBER	
W20368	LC13-GW2	SHEET OF

SOIL BORING LOG

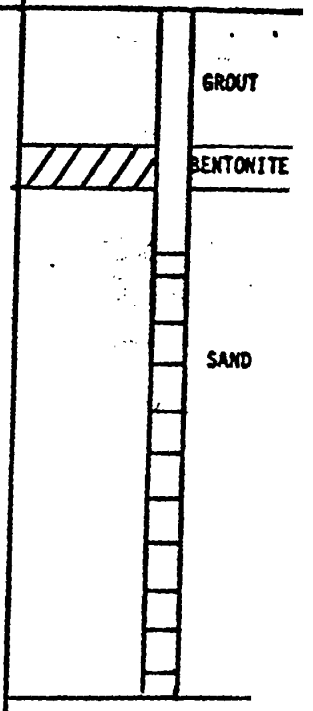
PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 6.60' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 5', 4/29/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
	5	4-6	S1	2.0	2-3-2-2	Fine sand w/some silt and clay; yel. brown (10YR5/4)-olive gray(5YR5/6); wet at 5'	
	10	9-11	S2	2.0	4-3-4-4		
	15	14-16	S3	2.0	4-4-4-5	F-M sand; yell. orange(10YR6/6); wet	
	20						



PROJECT NUMBER	BORING NUMBER	
W20368	LC13-GW3	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 8.03' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 5', 4/30/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
		0-2	S1	1.5	7-7-6-3	Fine sand w/some clay, tr. gravel; yel. brown(10YR4/2) -olive gray(5Y6/1); wet at 5'		GROUT
	5	4-6	S2	1.3	2-2-3-4			BENTONITE
	10	9-11	S3	1.6	5-6-6-7	F-M sand; yel. orange(10YR6/6)-yel. brown(10YR5/4); wet; grades to fine sand at 15'		SAND
	15	14-16	S4	2.0	2-3-5-7			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC13-GW4	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 8.36' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT AUGER

WATER LEVEL AND DATE 5', 4/30/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
		0-2	S1	1.6	5-6-4-3	Fine sand and clay; yel. brown (10YR4/2)-olive gray(5Y6/1); roots		GROUT
								BENTONITE
	5	4-6	S2	1.9	4-4-3-5			
								SAND
	10	9-11	S3	1.8	3-3-4-4	F-M sand; yel. orange(10YR6/6)-olive gray (5Y6/1);wet		
	15	14-16	S4	2.0	2-2-3-3			
	20							

PROJECT NUMBER	BORING NUMBER	
W20368	LC13-GW5	SHEET OF

SOIL BORING LOG

PROJECT CONFIRMATION STUDY LOCATION LITTLE CREEK

ELEVATION 8.00' DRILLING CONTRACTOR ATEC

DRILLING METHOD AND EQUIPMENT Auger

WATER LEVEL AND DATE 5', 5/1/86 START FINISH LOGGER SEXTON

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	WELL CONSTRUCTION: 2 inch PVC
						Fine sand and clay; yel. orange (10YR6/6)-yel. brown(10YR5/4); wet at 5'		GROUT; BENTONIT
	5	4-6	S1	1.6	1-2-2-5			
						F-M sand; yel. orange(10YR6/6)-olive brown(5Y5/6); wet		SAND
	10	9-11	S2	2.0	3-3-5-8			
	15	14-16	S3	2.0	2-4-4-6			
	20							

applied environmental

SOIL BORING BMW #1
DATE DRILLED 10/09/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Background Monitoring Well #1
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0					SC	Black and gray medium sand w/ clayey sand band.
5		3 3 4				
					SC	Black and gray clay w/ band of tan medium sand.
10		3 4 6				
					SC	Brown and gray clay w/ some sand.
		10 7 8				

METHOD OF DRILLING Hollow stem drilling
HOLE DIAMETER 12 inches
COMPLETION DEPTH 13.0 FEET
WELL DIAMETER 4 inches
WELL MATERIAL PVC
SAMPLING METHOD SPLIT SPOON

applied environmental inc.

SOIL BORING BMW #2
DATE DRILLED 10/09/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Background Monitoring Well #2
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0					SC	Brown medium sand w/ clayey sand bands.
5		3 3 4				
					SC	Gray soft clay w/ 3" band of medium sand.
10		2 1 1				
					SC	Gray soft clay w/ 2" band of sand.
		1 1 1				

METHOD OF DRILLING Hollow stem drilling
HOLE DIAMETER 12 inches
COMPLETION DEPTH 13.0 FEET
WELL DIAMETER 4 inches
WELL MATERIAL PVC
SAMPLING METHOD SPLIT SPOON

applied environmental inc.

SOIL BORING BMW #3
DATE DRILLED 10/09/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Background Monitoring Well #3
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0					SC	Brown medium-fine sand becomes gray clay w/ some sand.
5		1 WOH WOH			SC	Gray clay w/ a small amount of sand.
10		3 3 3				

METHOD OF DRILLING Hollow stem drilling
HOLE DIAMETER 12 inches
COMPLETION DEPTH 6.0 FEET
WELL DIAMETER 4 inches
WELL MATERIAL PVC
SAMPLING METHOD SPLIT SPOON

applied environmental inc.

SOIL BORING BMW #4
DATE DRILLED 10/10/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Background Monitoring Well #4
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0					SP	Tan medium sand.
5		13 16 19				
					SC	Gray clay w/ bands of medium sand.
10		2 2 4				
					SC	Gray medium sand w/ gray clay.
		2 2 3				

METHOD OF DRILLING Hollow stem drilling
HOLE DIAMETER 12 inches
COMPLETION DEPTH 13.0 FEET
WELL DIAMETER 4 inches
WELL MATERIAL PVC
SAMPLING METHOD SPLIT SPOON

applied environmental

SOIL BORING BMW #5
DATE DRILLED 10/10/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Background Monitoring Well #5
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS.	LITHOLOGIC DESCRIPTION
0					SP	Brown medium sand.
5		4 3 4				
10		8 7 11				
		6 8 3				

METHOD OF DRILLING Hollow stem drilling
HOLE DIAMETER 12 inches
COMPLETION DEPTH 13 FEET
WELL DIAMETER 4 inches
WELL MATERIAL PVC
SAMPLING METHOD SPLIT SPOON

applied environmental inc.

SOIL BORING BMW #6
DATE DRILLED 10/04/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Background Monitoring Well #6
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0						Asphalt. Crushed Stone Base.
					SP	Brown medium sand.
5		7 12 17				
10		7 7 6				
		6 7 12				

METHOD OF DRILLING Hollow stem drilling
HOLE DIAMETER 12 inches
COMPLETION DEPTH 13.0 FEET
WELL DIAMETER 4 inches
WELL MATERIAL PVC
SAMPLING METHOD SPLIT SPOON

applied environmental inc

SOIL BORING BMW #7
DATE DRILLED 10/10/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Background Monitoring Well #7
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0						Asphalt, Crushed Stone Base.
					SC	Brown medium sand w/ clay.
5		3 1 2				
					SP	Tan medium sand.
10		6 10 12				
					SP	White medium sand.
		10 10 14				

METHOD OF DRILLING Hollow stem drilling
HOLE DIAMETER 12 inches
COMPLETION DEPTH 13.0 FEET
WELL DIAMETER 4 inches
WELL MATERIAL PVC
SAMPLING METHOD SPLIT SPOON

applied environmental

SOIL BORING BMW #8
DATE DRILLED 10/10/91
CLIENT PRC, Inc.
PROJECT NAB Little Creek
LOCATION Background Monitoring Well #8
GEOLOGIC FORMATION Yorktown and Bacons Castle Formations

DEPTH (feet)	SAMPLE	BLOWS/6 IN	PID (ppm) 0 5 10	GRAPHIC LOG	SOIL CLASS	LITHOLOGIC DESCRIPTION
0						Asphalt. Crushed Stone Base.
					SP	Gray medium sand.
5		4 5 4				
					SC	Gray sandy clay.
10		1 NOH NOH				

METHOD OF DRILLING Hollow stem drilling
HOLE DIAMETER 12 inches
COMPLETION DEPTH 12.0 FEET
WELL DIAMETER 4 inches
WELL MATERIAL PVC
SAMPLING METHOD SPLIT SPOON

APPENDIX C

Monitoring Well Construction Diagrams

WELL CONSTRUCTION LOG
(UNCONSOLIDATED)

Project NAB-Little Creek CTO-0042 Well 07-MW-05D

Location Site 7 - Sanitary Landfill

Town/City Virginia Beach

County N/A State Virginia

Permit No. N/A

Land-Surface Elevation and Datum 6.10 feet

Installation Date (s) 7/15/93

Drilling Method 4 1/4" hollow stem auger

Drilling Contractor McCallum

Drilling Fluid N/A

Development Technique(s) and Dates (s) Pump - 7/15/93

Water Removed During Development 30 gallons

Static Depth to Water 5.78 feet below top of casing

Pumping Depth to Water N/A feet below top of casing

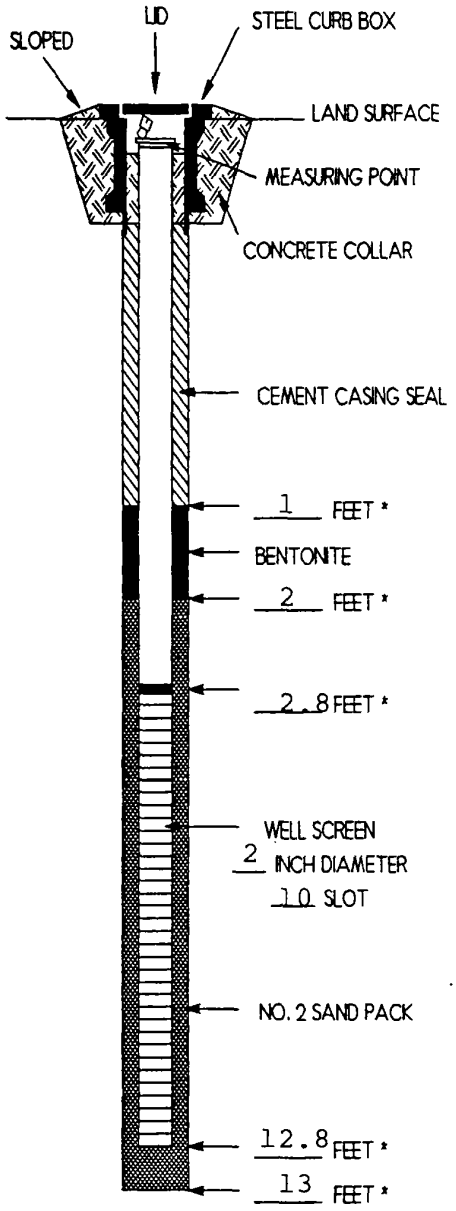
Total Pumping Duration 45 minutes

Yield 0.75 gpm

Well Purpose Groundwater monitoring

Remarks

Geologist/# M. Schmidt



* DEPTH BELOW LAND SURFACE

WELL CONSTRUCTION LOG
(UNCONSOLIDATED)

Project NAB-Little Creek CTO-0042 Well 12-MW-01

Location Site 12 - Exchange Laundry Waste Disposal Area

Town/City Virginia Beach

County N/A State Virginia

Permit No. N/A

Land-Surface Elevation and Datum 12.40 feet

Installation Date (s) 5/24/93

Drilling Method 4 1/4" hollow stem auger

Drilling Contractor McCallum

Drilling Fluid N/A

Development Technique(s) and Dates (s) Pump - 5/24/93

Water Removed During Development 35 gallons

Static Depth to Water 6.6 feet below ground level

Pumping Depth to Water N/A feet below ground level

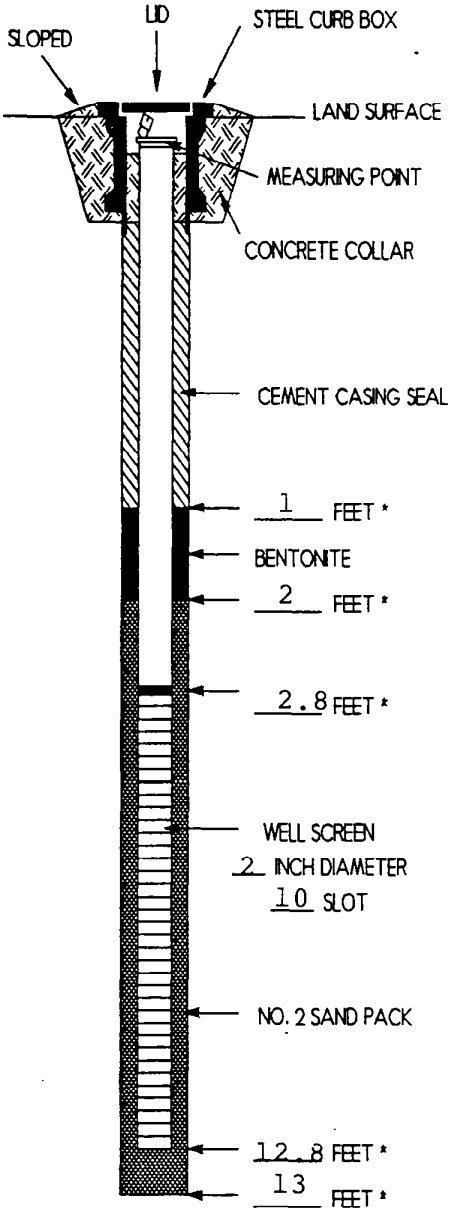
Total Pumping Duration 15 minutes

Yield 3.0 gpm

Well Purpose Groundwater monitoring

Remarks

Geologist/# M. Schmidt



* DEPTH BELOW LAND SURFACE

WELL CONSTRUCTION LOG
(UNCONSOLIDATED)

Project NAB-Little Creek CTO-0042 Well 12-MW-02

Location Site 12 - Exchange Laundry Waste Disposal Area

Town/City Virginia Beach

County N/A State Virginia

Permit No. N/A

Land-Surface Elevation and Datum 11.20 feet

Installation Date (s) 5/24/93

Drilling Method 4 1/4" hollow stem auger

Drilling Contractor McCallum

Drilling Fluid N/A

Development Technique(s) and Dates (s) Pump - 5/24/93

Water Removed During Development 50 gallons

Static Depth to Water N/A feet below ground level

Pumping Depth to Water N/A feet below ground level

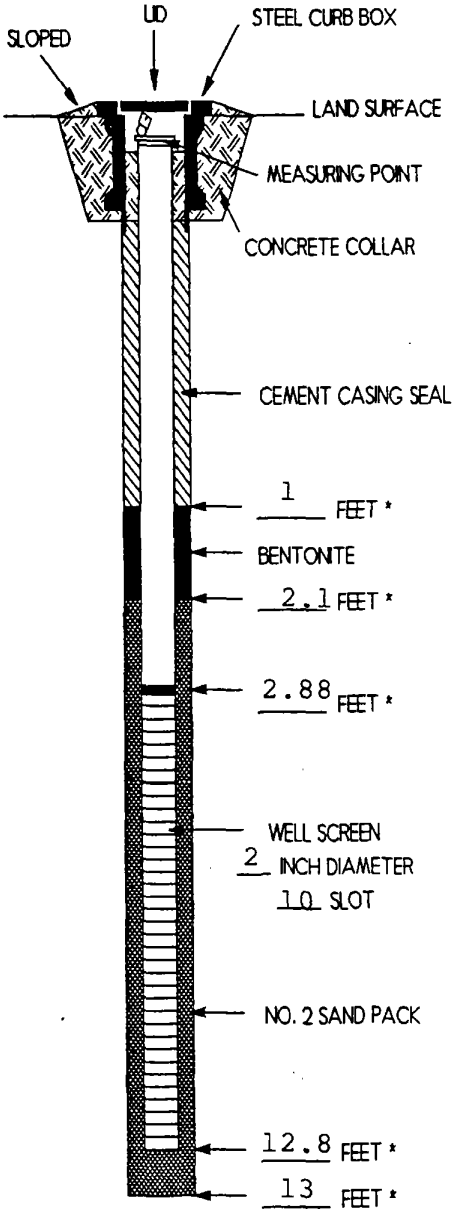
Total Pumping Duration 20 minutes

Yield 2.5 gpm

Well Purpose Groundwater monitoring

Remarks

Geologist/# D. Place



* DEPTH BELOW LAND SURFACE

WELL CONSTRUCTION LOG
(UNCONSOLIDATED)

Project NAB-Little Creek CTO-0042 Well 12-MW-03

Location Site 12 - Exchange Laundry Waste Disposal Area

Town/City Virginia Beach

County N/A State Virginia

Permit No. N/A

Land-Surface Elevation and Datum 11.50 feet

Installation Date (s) 5/24/93

Drilling Method 4 1/4" hollow stem auger

Drilling Contractor McCallum

Drilling Fluid M/A

Development Technique(s) and Dates (s) Pump - 5/24/93

Water Removed During Development 40 gallons

Static Depth to Water 9.5 feet below top of casing

Pumping Depth to Water N/A feet below top of casing

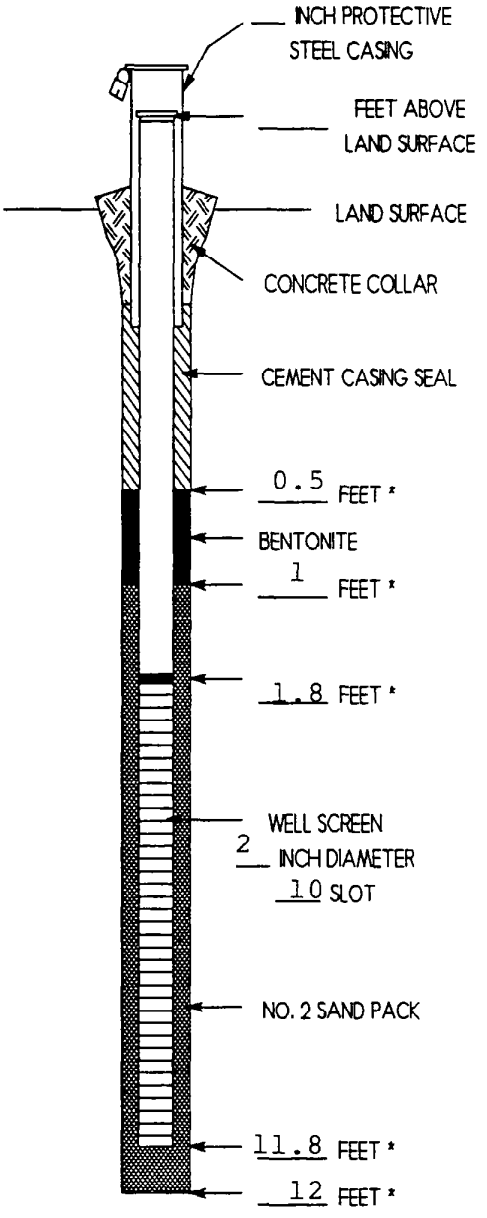
Total Pumping Duration 10 minutes

Yield 4 gpm

Well Purpose Groundwater monitoring

Remarks Water was initially brown, but cleared after a few minutes.

Geologist/# M. Schmidt



* DEPTH BELOW LAND SURFACE

WELL CONSTRUCTION LOG
(UNCONSOLIDATED)

Project NAB-Little Creek CTO-0042 Well 12-MW-04

Location Site 12 - Exchange Laundry Waste Disposal Area

Town/City Virginia Beach

County N/A State Virginia

Permit No. N/A

Land-Surface Elevation and Datum 11.70 feet

Installation Date (s) 5/24/93

Drilling Method 4 1/4" hollow stem auger

Drilling Contractor McCallum

Drilling Fluid N/A

Development Technique(s) and Dates (s) Pump - 5/24/93

Water Removed During Development 45 gallons

Static Depth to Water 9' 3 1/4" feet below top of casing

Pumping Depth to Water 9' 3 1/2" feet below top of casing

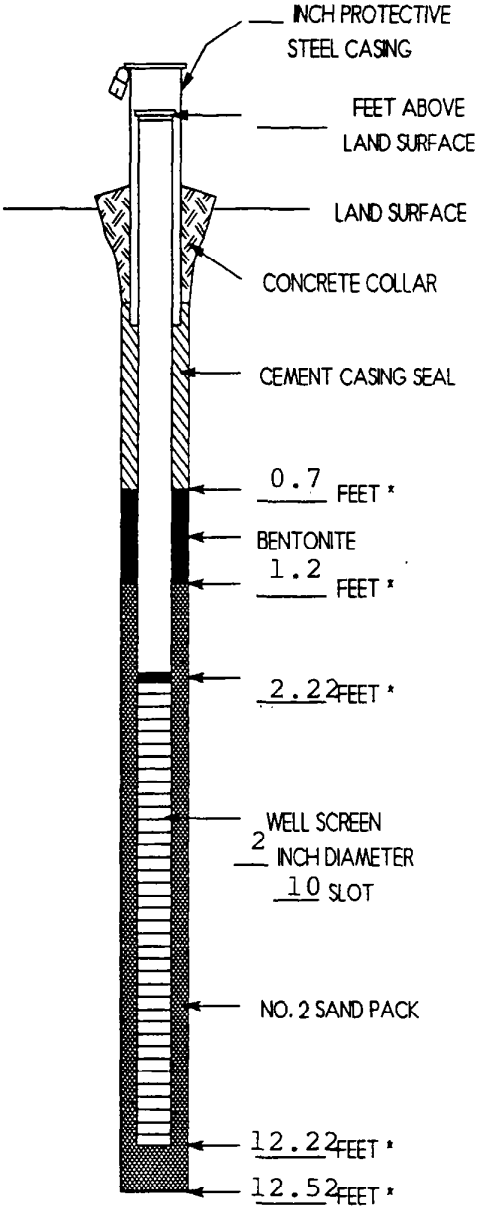
Total Pumping Duration 11 minutes

Yield 4 gpm

Well Purpose Groundwater monitoring

Remarks

Geologist/# D. Place



* DEPTH BELOW LAND SURFACE

WELL CONSTRUCTION LOG
(UNCONSOLIDATED)

Project NAB-Little Creek CTO-0042 Well 13-MW-06

Location Site 13 - Public Works PCP Dip Tank and Wash Rack

Town/City Virginia Beach

County N/A State Virginia

Permit No. N/A

Land-Surface Elevation and Datum 7.8 feet

Installation Date (s) 6/28/93

Drilling Method 4 1/4" hollow stem auger

Drilling Contractor McCallum

Drilling Fluid N/A

Development Technique(s) and Dates (s) Pump - 6/29/93

Water Removed During Development 55 gallons

Static Depth to Water 5.04 feet below ground level

Pumping Depth to Water N/A feet below ground level

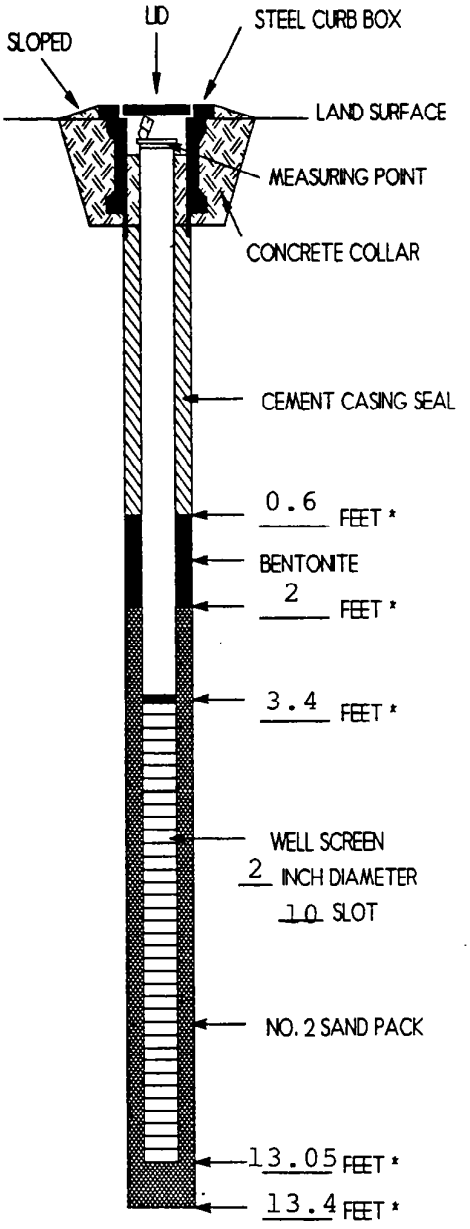
Total Pumping Duration 6 minutes

Yield 9 gpm

Well Purpose Groundwater monitoring

Remarks

Geologist/# D. Place



* DEPTH BELOW LAND SURFACE

WELL CONSTRUCTION LOG
(UNCONSOLIDATED)

Project NAB-Little Creek CTO-0042 Well 13-MW-07

Location Site 13 - Public Works PCP Dip Tank and Wash Rack

Town/City Virginia Beach

County N/A State Virginia

Permit No. N/A

Land-Surface Elevation and Datum 8.3 feet

Installation Date (s) 6/28/93

Drilling Method 4 1/4" hollow stem auger

Drilling Contractor McCallum

Drilling Fluid N/A

Development Technique(s) and Dates (s) Pump - 6/29/93

Water Removed During Development 55 gallons

Static Depth to Water 5.63 feet below ground level

Pumping Depth to Water N/A feet below ground level

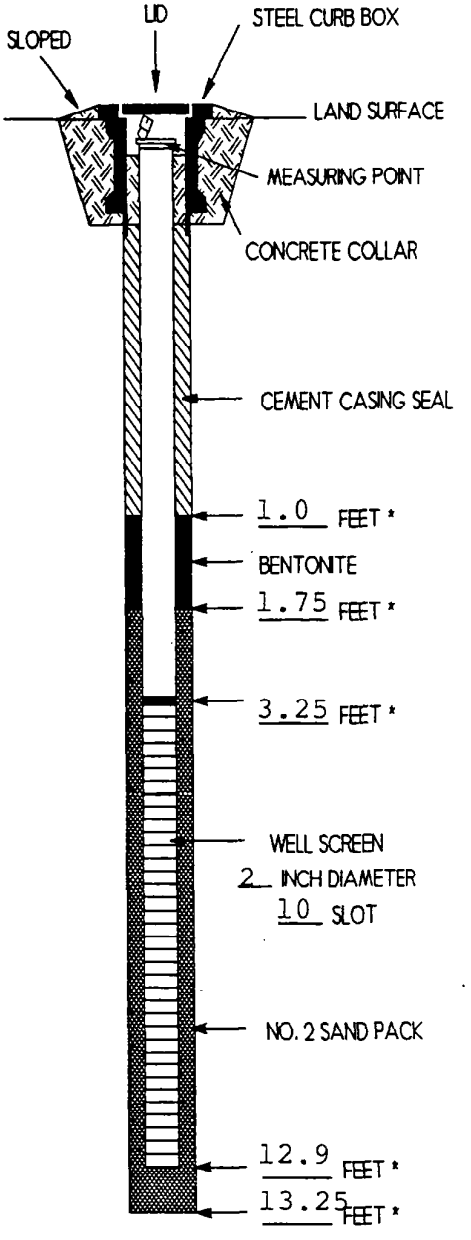
Total Pumping Duration 6 minutes

Yield 9 gpm

Well Purpose Groundwater monitoring

Remarks

Geologist/# D. Place



* DEPTH BELOW LAND SURFACE

WELL CONSTRUCTION LOG
(UNCONSOLIDATED)

Project NAB-Little Creek CTO-0042 Well 13-MW-08

Location Site 13 - Public Works PCP Dip Tank and Wash Rack

Town/City Virginia Beach

County N/A State Virginia

Permit No. N/A

Land-Surface Elevation and Datum 7.8 feet

Installation Date (s) 6/28/93

Drilling Method 4 1/4" hollow stem auger

Drilling Contractor McCallum

Drilling Fluid N/A

Development Technique(s) and Dates (s) Pump - 6/29/93

Water Removed During Development 55 gallons

Static Depth to Water 5.25 feet below ground level

Pumping Depth to Water N/A feet below ground level

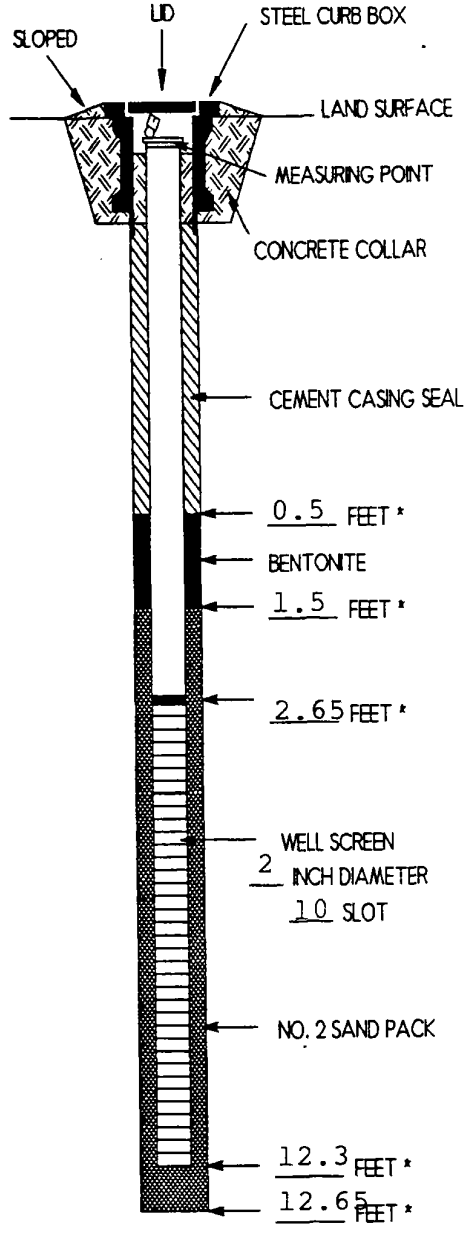
Total Pumping Duration 6 minutes

Yield 9 gpm

Well Purpose Groundwater monitoring

Remarks

Geologist/# D. Place

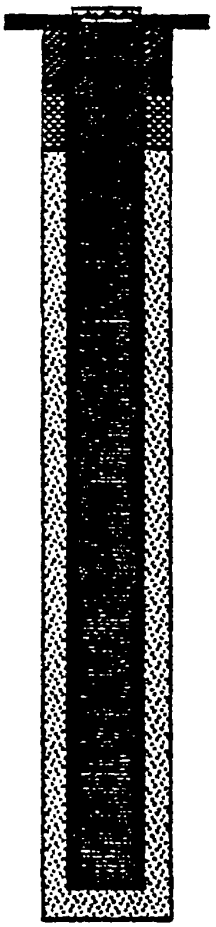


* DEPTH BELOW LAND SURFACE

Existing monitoring well construction diagrams available for use with this RI.

Site 9

Soil Boring MW-1
Date drilled 09-30-91
Project NAB Little Creek
Location Building 3699
Water level 9.50' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 2 Feet

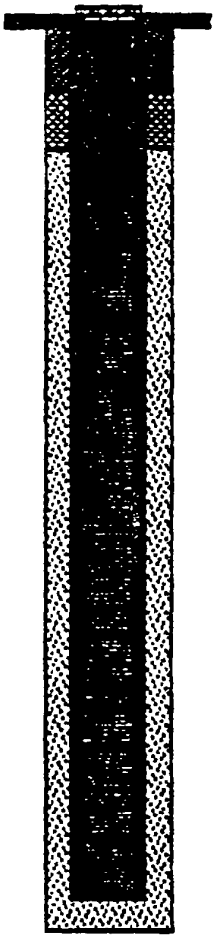
0 - 7 Feet SOLID RISER

SAND PACK 2 - 17 Feet

7 - 17 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring MW-2
Date drilled 09-30-91
Project NAB Little Creek
Location Building 3699
Water level 8.41' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 2 Feet

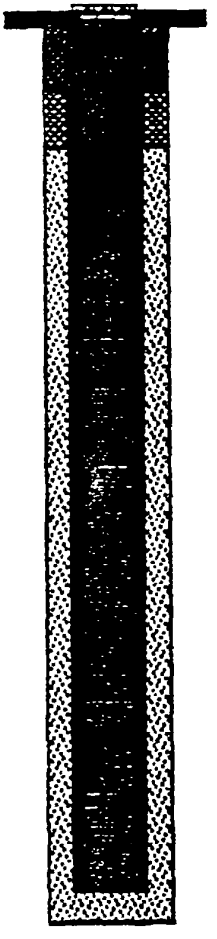
0 - 5 Feet SOLID RISER

SAND PACK 2 - 15 Feet

5 - 15 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring MW-3
Date drilled 09-30-91
Project NAB Little Creek
Location Building 3699
Water level 8.14' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 3 Feet

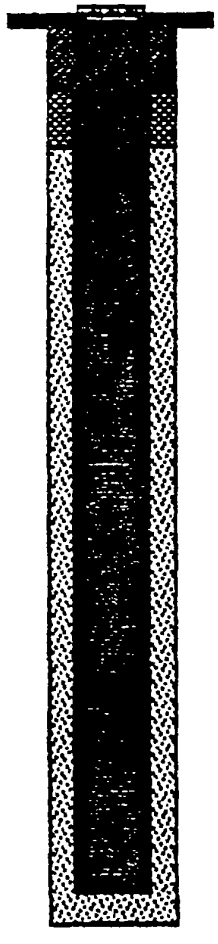
0 - 5 Feet SOLID RISER

SAND PACK 3 - 15 Feet

5 - 15 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring MW-4
Date drilled 09-30-91
Project NAB Little Creek
Location Building 3699
Water level 8.10' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 3 Feet

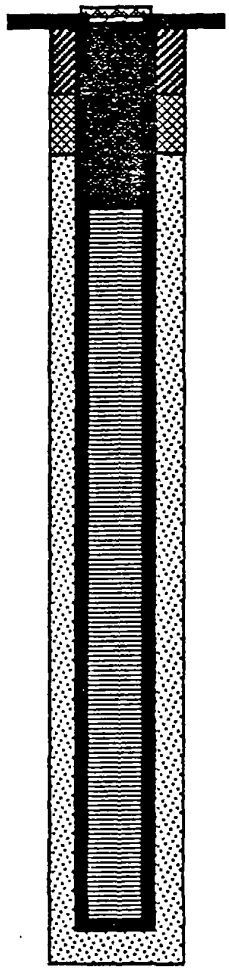
0 - 5 Feet SOLID RISER

SAND PACK 3 - 15 Feet

5 - 15 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring BMW-1
Date drilled 10-09-91
Project NAB Little Creek
Location Background Well #1
Water level 8.72' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 2 Feet

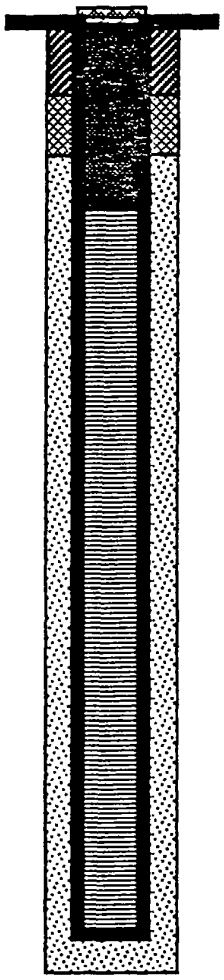
0 -3 Feet SOLID RISER

SAND PACK 2 - 13 Feet

3 - 13 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring BMW-2
Date drilled 10-09-91
Project NAB Little Creek
Location Background Well #2
Water level 2.10' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 2 Feet

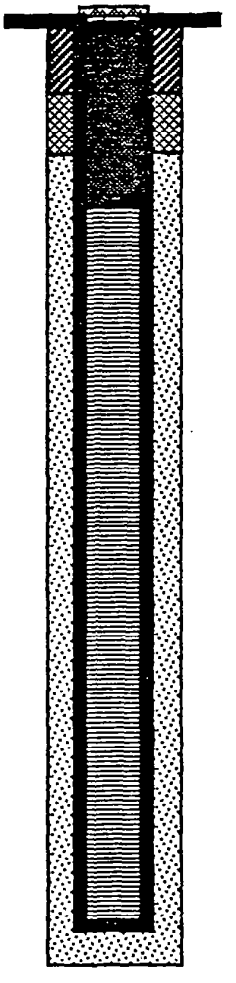
0 -3 Feet SOLID RISER

SAND PACK 2 - 13 Feet

3 - 13 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring BMW-3
Date drilled 10-09-91
Project NAB Little Creek
Location Background Well #3
Water level 5.90' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL N/A Feet

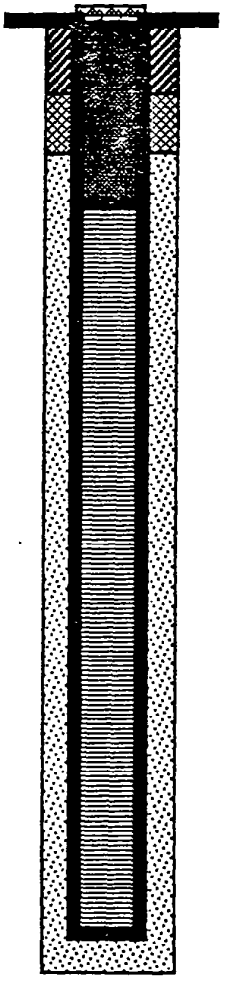
N/A Feet SOLID RISER

SAND PACK 1 - 6 Feet

1 - 6 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring BMW-4
Date drilled 10-10-91
Project NAB Little Creek
Location Background Well #4
Water level 6.39' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 2 Feet

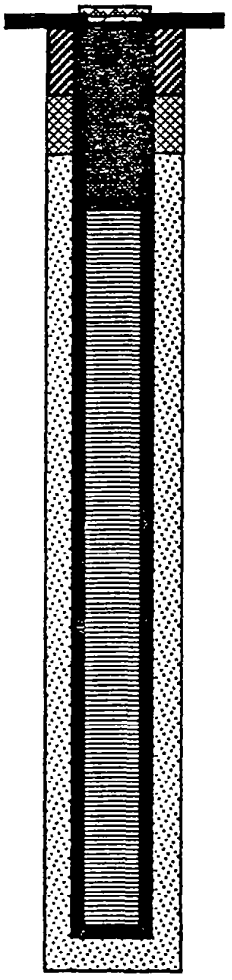
0 - 3 Feet SOLID RISER

SAND PACK 2 - 13 Feet

3 - 13 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring BMW-5
Date drilled 10-10-91
Project NAB Little Creek
Location Background Well #5
Water level 5.18' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 2 Feet

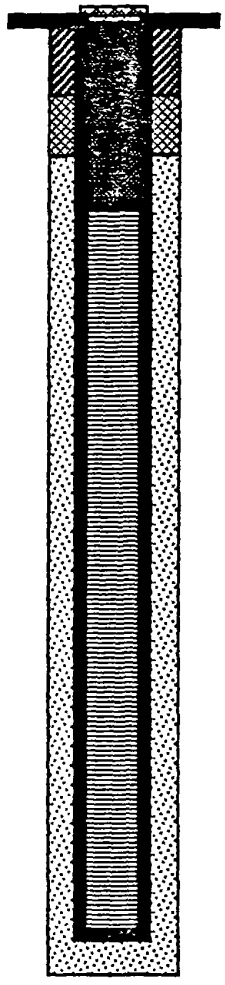
0 - 3 Feet SOLID RISER

SAND PACK 2 - 13 Feet

3 - 13 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring BMW-6
Date drilled 10-10-91
Project NAB Little Creek
Location Background Well #6
Water level 6.89' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 2 Feet

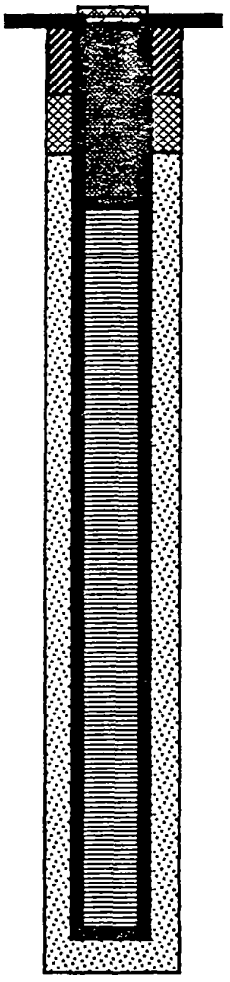
0 - 3 Feet SOLID RISER

SAND PACK 2 - 13 Feet

3 - 13 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring BMW-7
Date drilled 10-10-91
Project NAB Little Creek
Location Background Well #7
Water level 4.61' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL 1 - 2 Feet

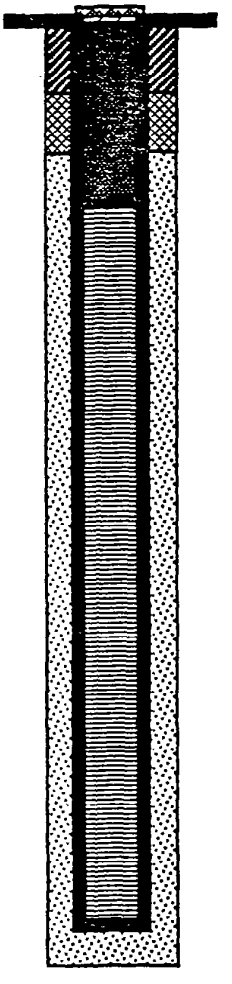
0 - 3 Feet SOLID RISER

SAND PACK 2 - 13 Feet

3 - 13 Feet SLOTTED SCREEN

Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

Soil Boring BMW-8
Date drilled 10-10-91
Project NAB Little Creek
Location Background Well #8
Water level 4.84' B.G.



GROUT 0 - 1 Feet

BENTONITE SEAL N/A Feet

0 -2 Feet SOLID RISER

SAND PACK 1 - 12 Feet

2 - 12 Feet SLOTTED SCREEN

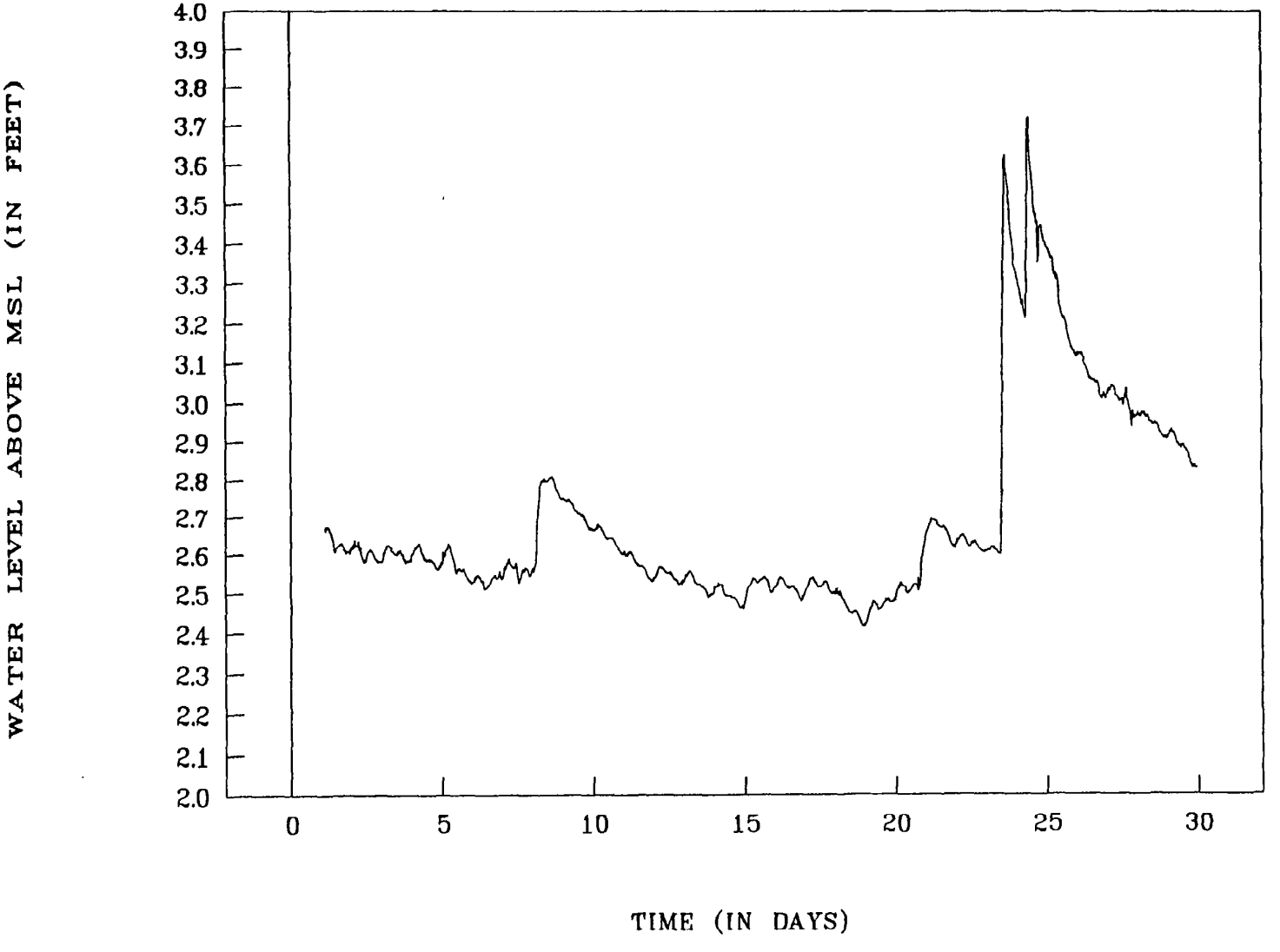
Well riser constructed of 4" schedule 40 PVC
with .020 " slotted screen.

APPENDIX D

Water Level Data
(includes Tidal Survey Results)

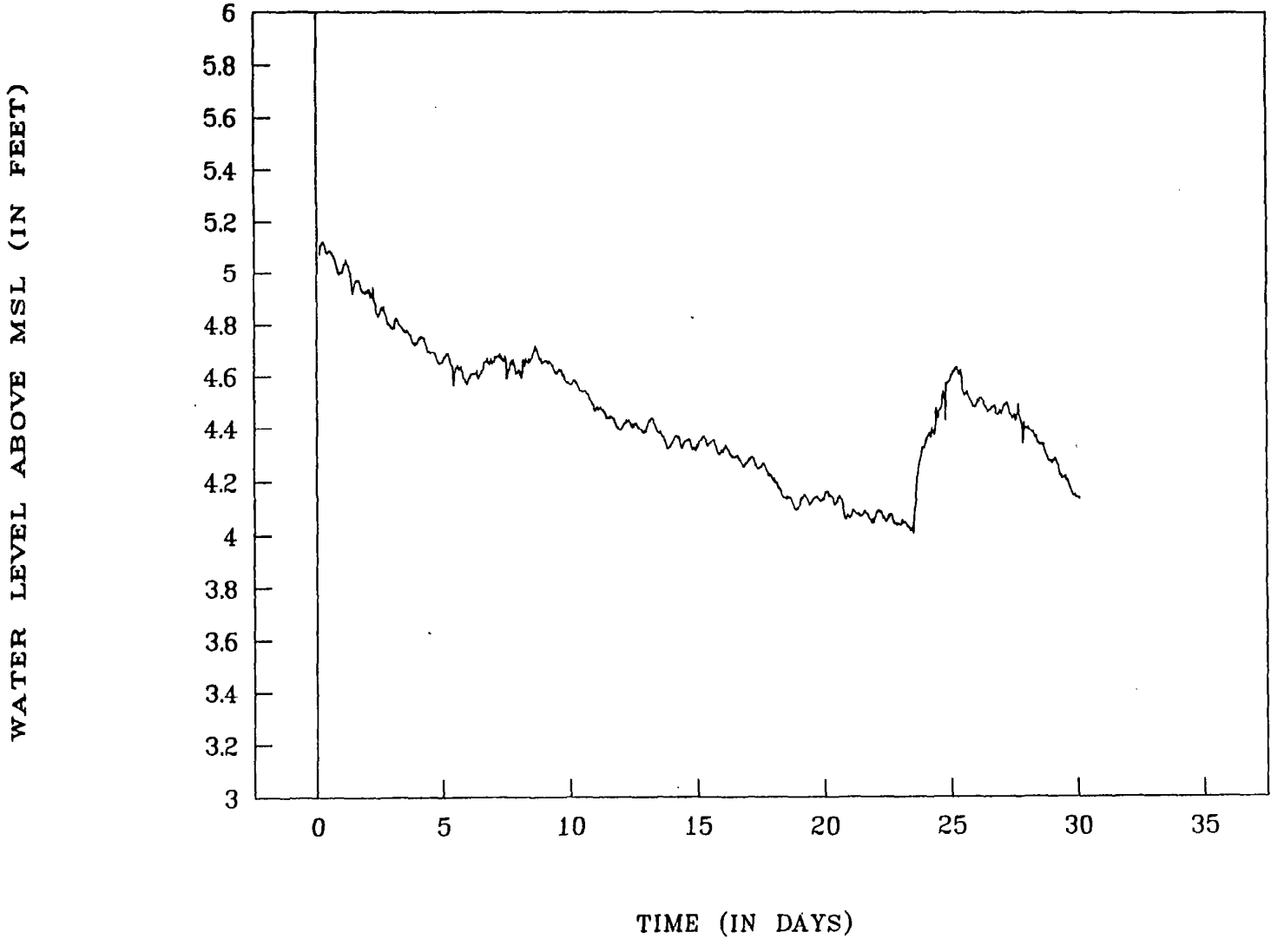
LITTLE CREEK RI/FS

SITE 7 MONITORING WELL GW1



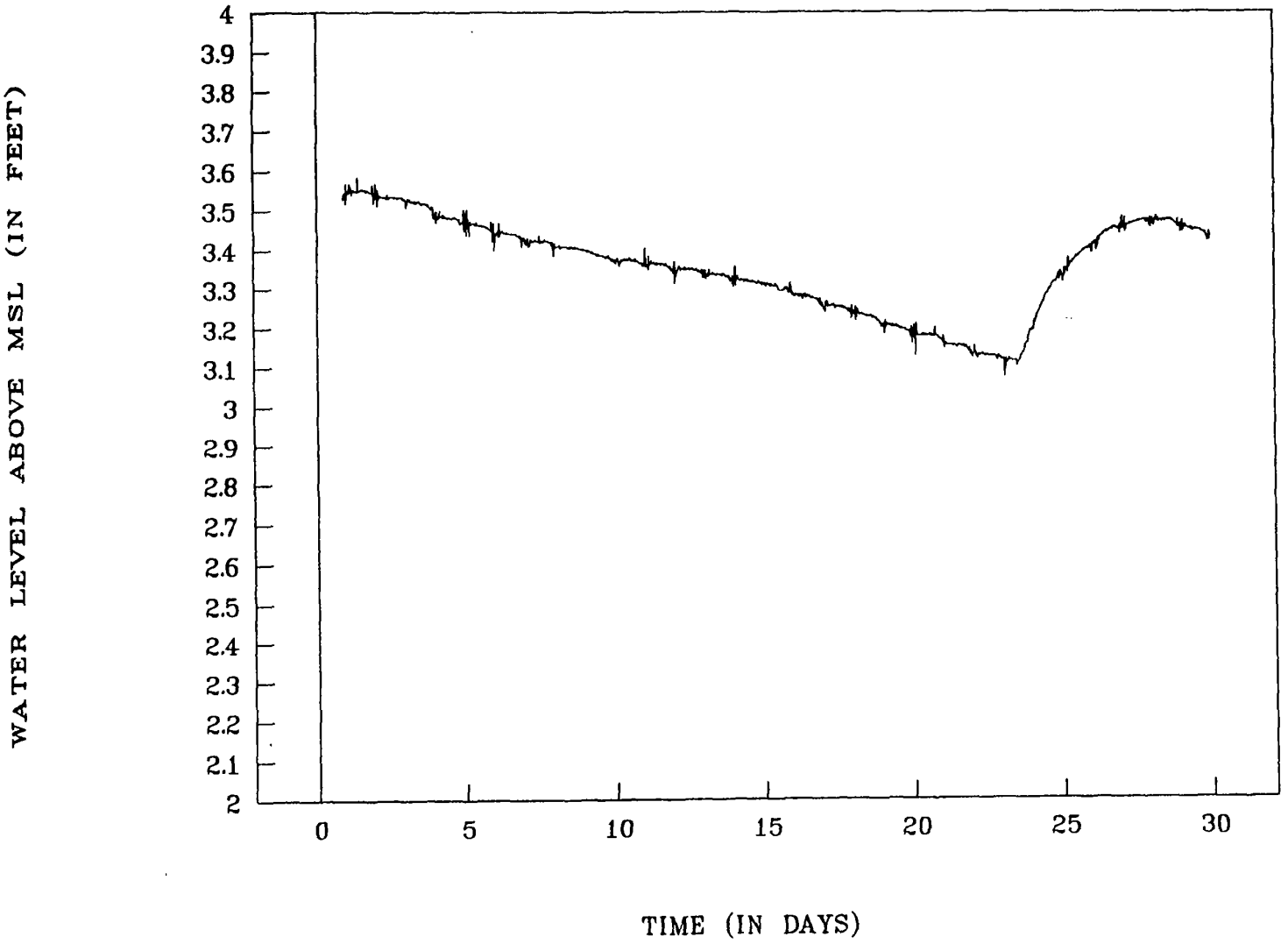
LITTLE CREEK RI/FS

SITE 7 MONITORING WELL GW3



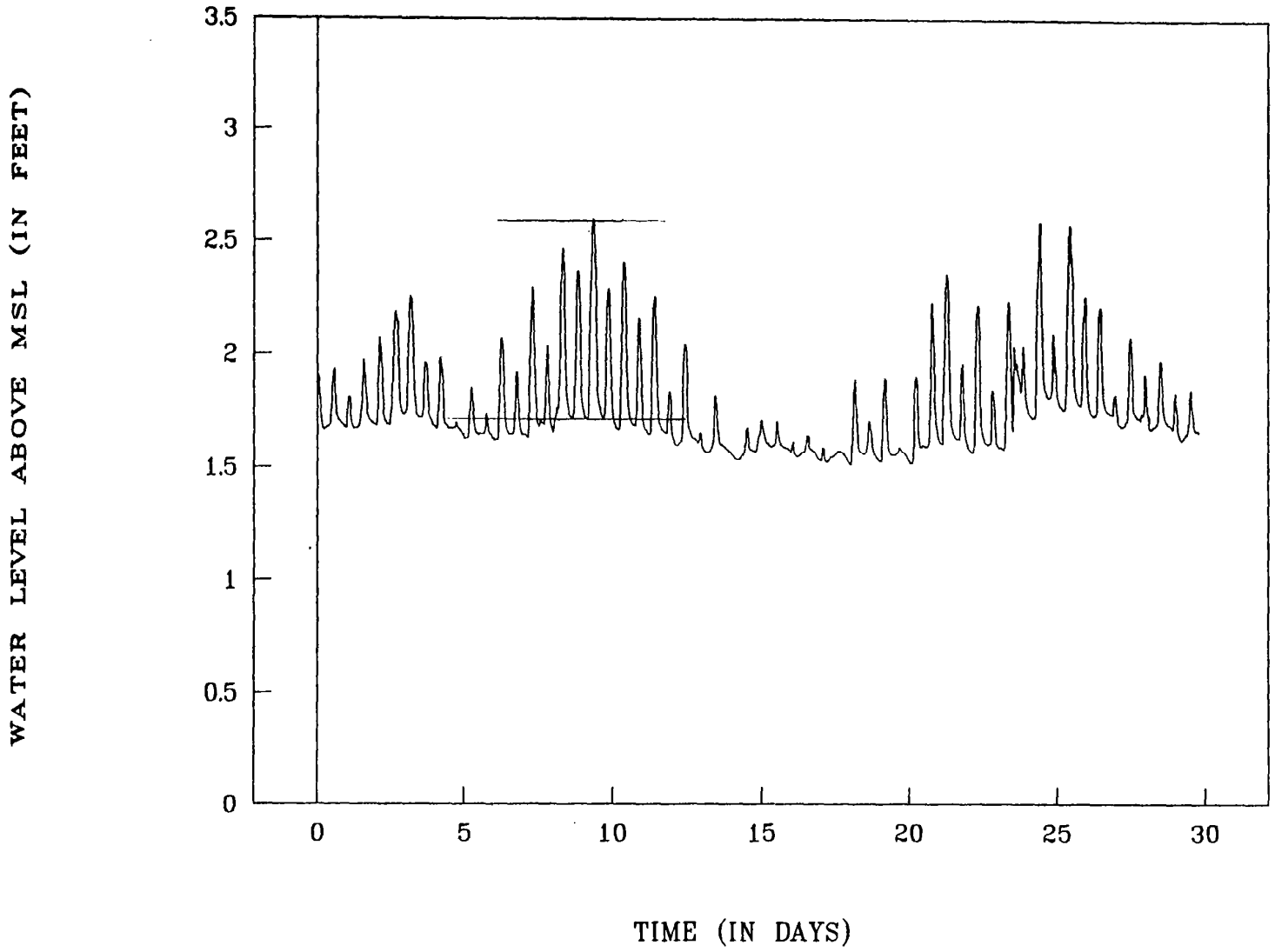
LITTLE CREEK RI/FS

SITE 9 MONITORING WELL GW5



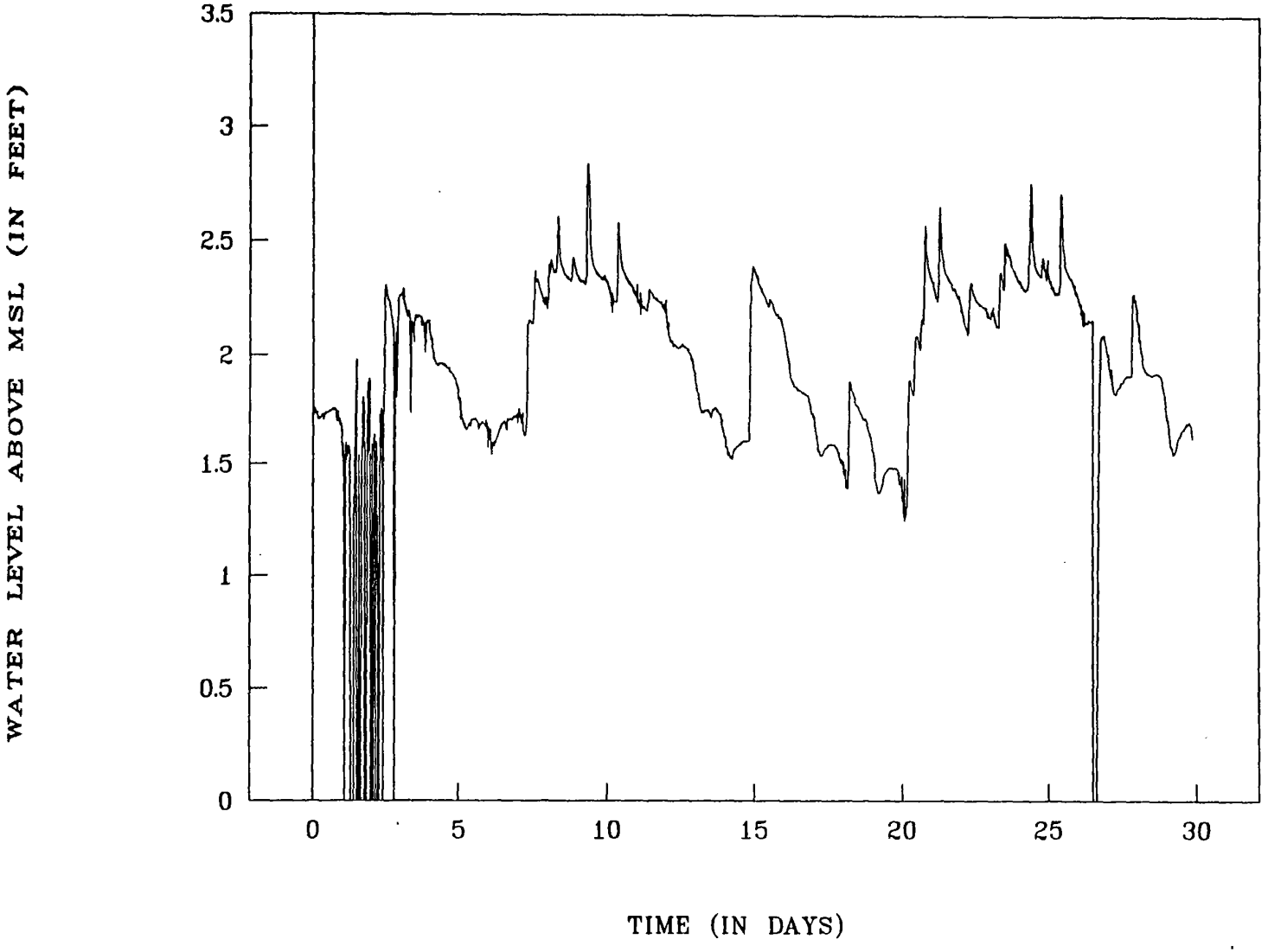
LITTLE CREEK RI/FS

SITE 7 MONITORING WELL GW6



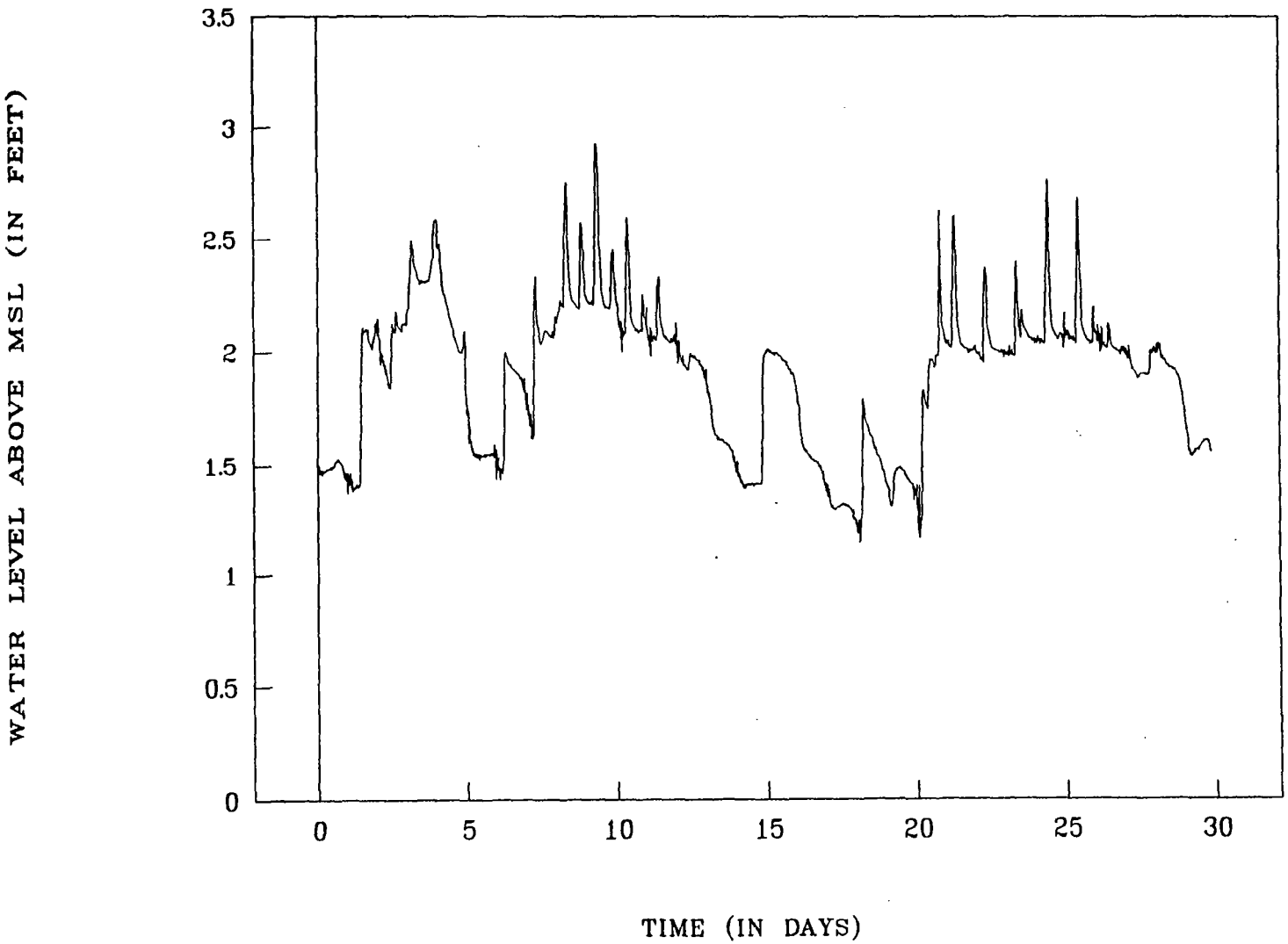
LITTLE CREEK RI/FS

SITE 7 MONITORING WELL GW8



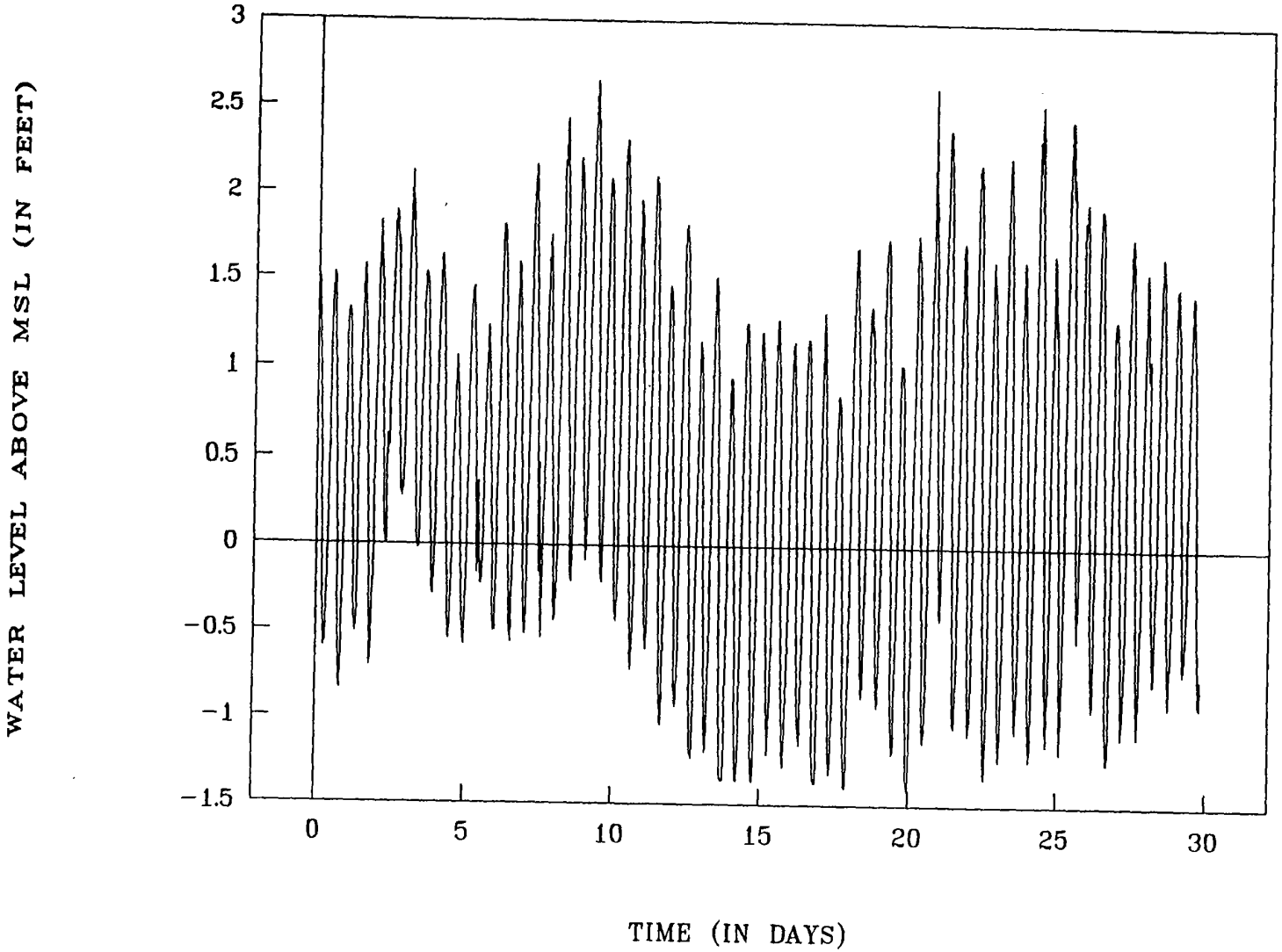
LITTLE CREEK RI/FS

SITE 7 MONITORING WELL GW7



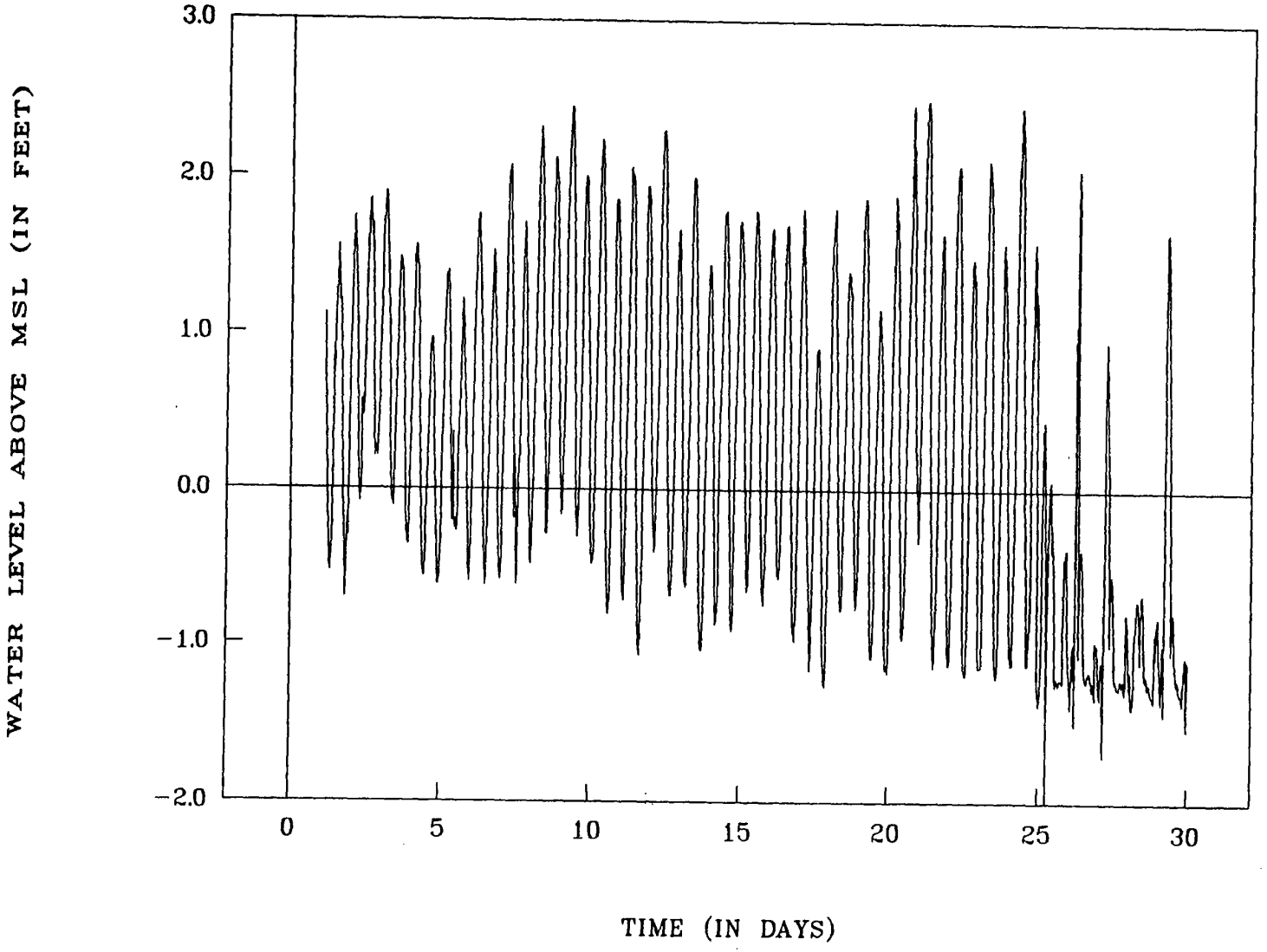
LITTLE CREEK RI/FS

SITE 7 STAFF GAUGE SG1



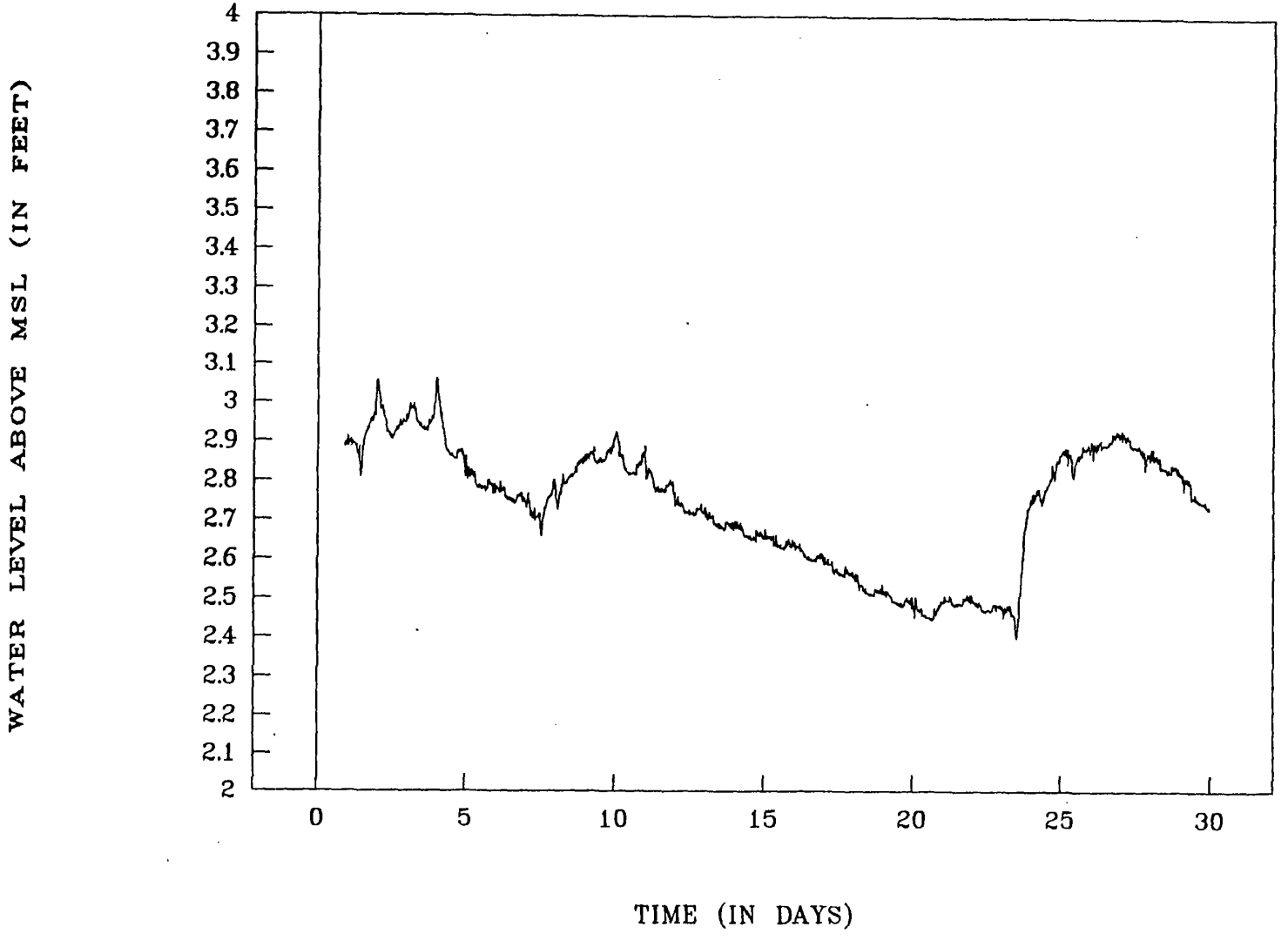
LITTLE CREEK RI/FS

SITE 7 STAFF GAUGE SG-2



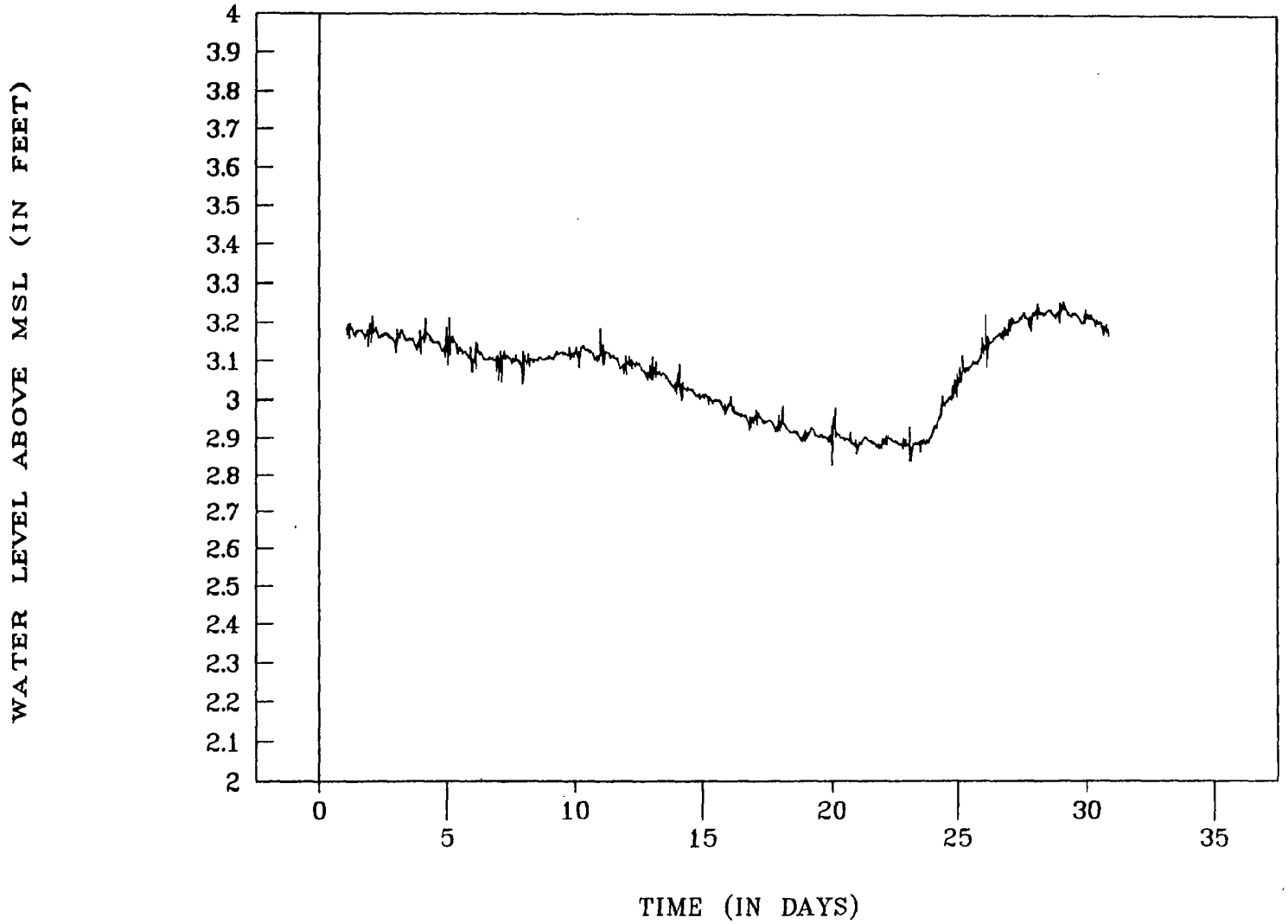
LITTLE CREEK RI/FS

SITE 9 MONITORING WELL GW6



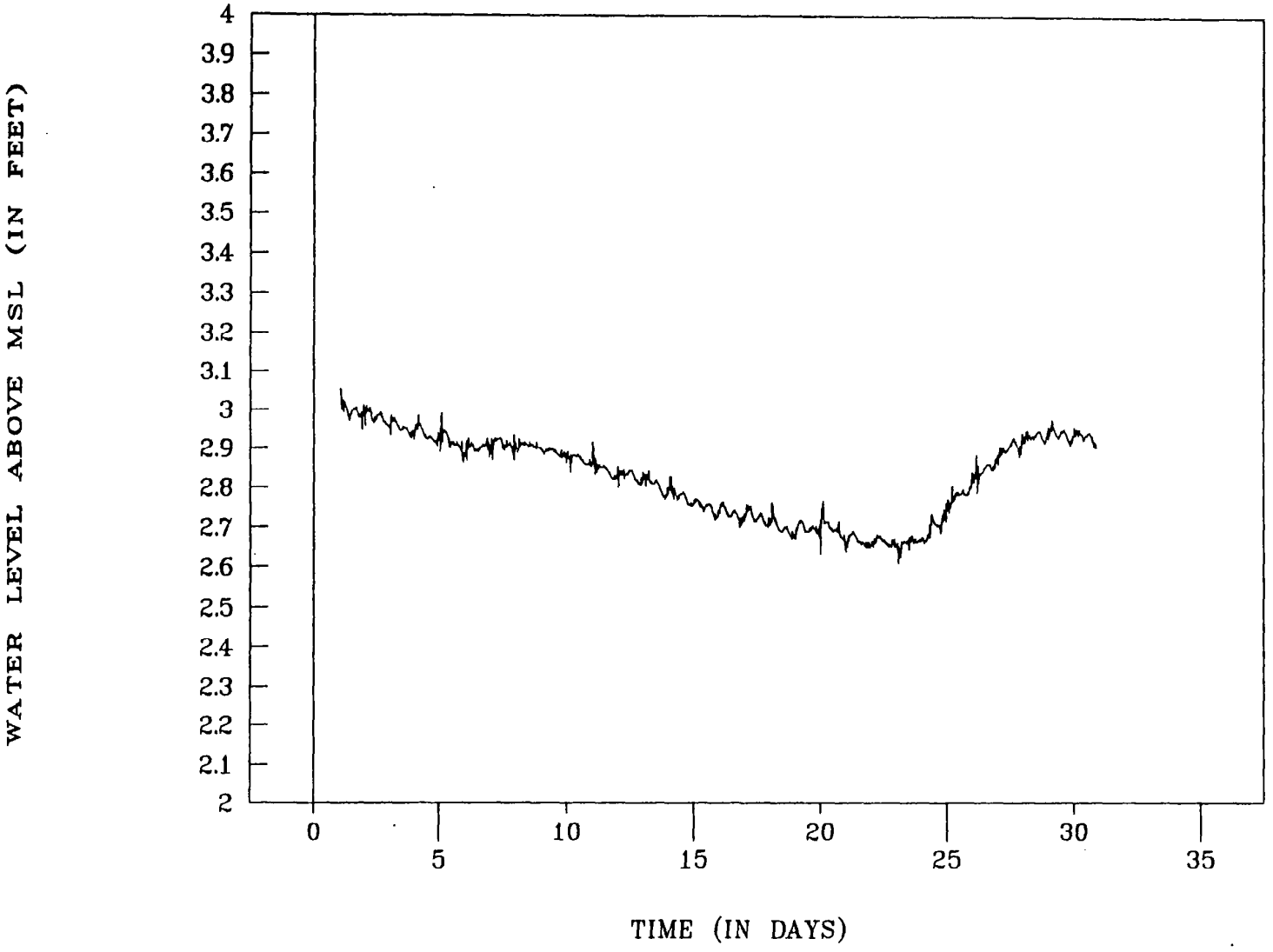
LITTLE CREEK RI/FS

SITE 10 MONITORING WELL GW2



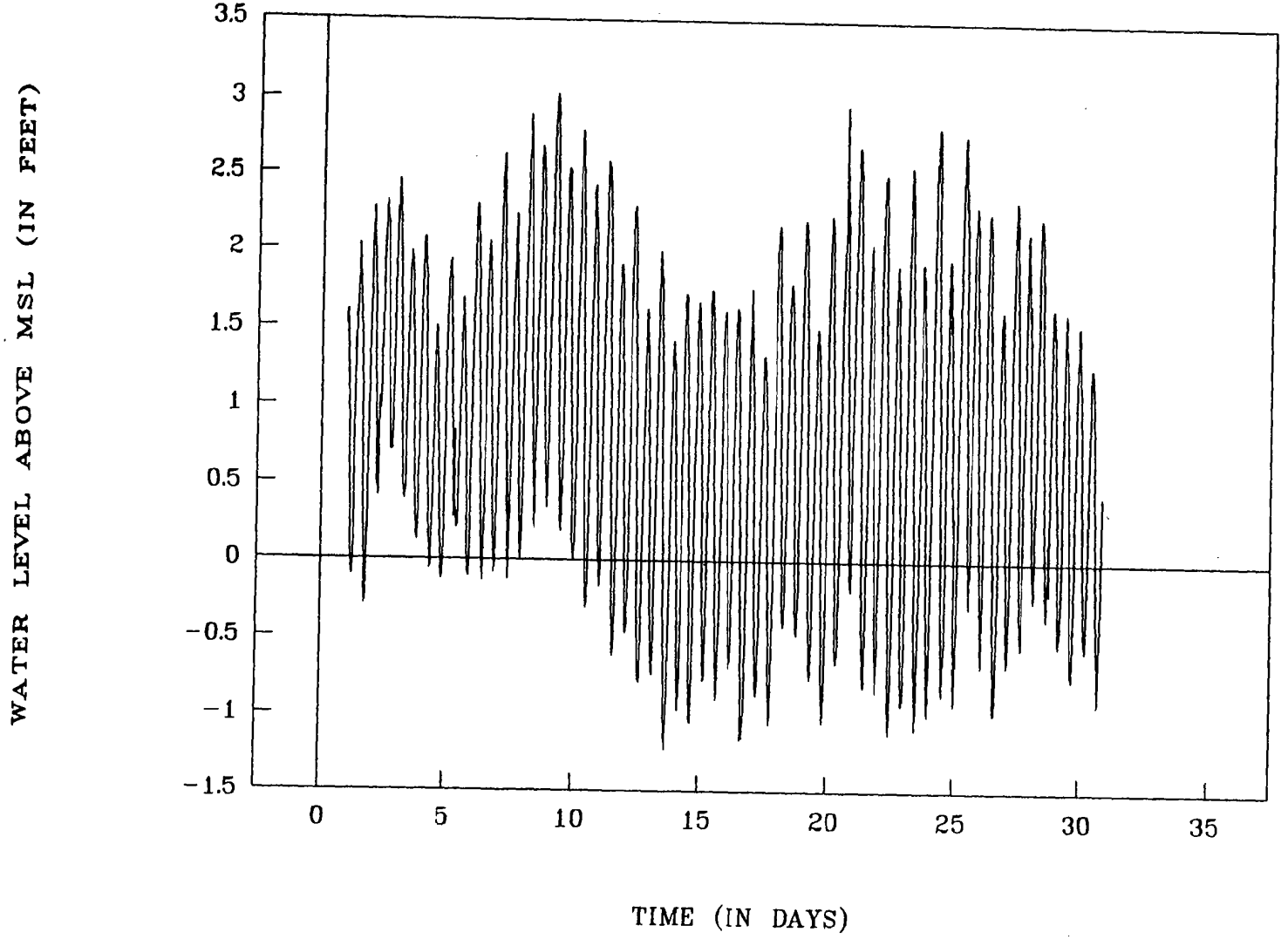
LITTLE CREEK RI/FS

SITE 10 MONITORING WELL GW5



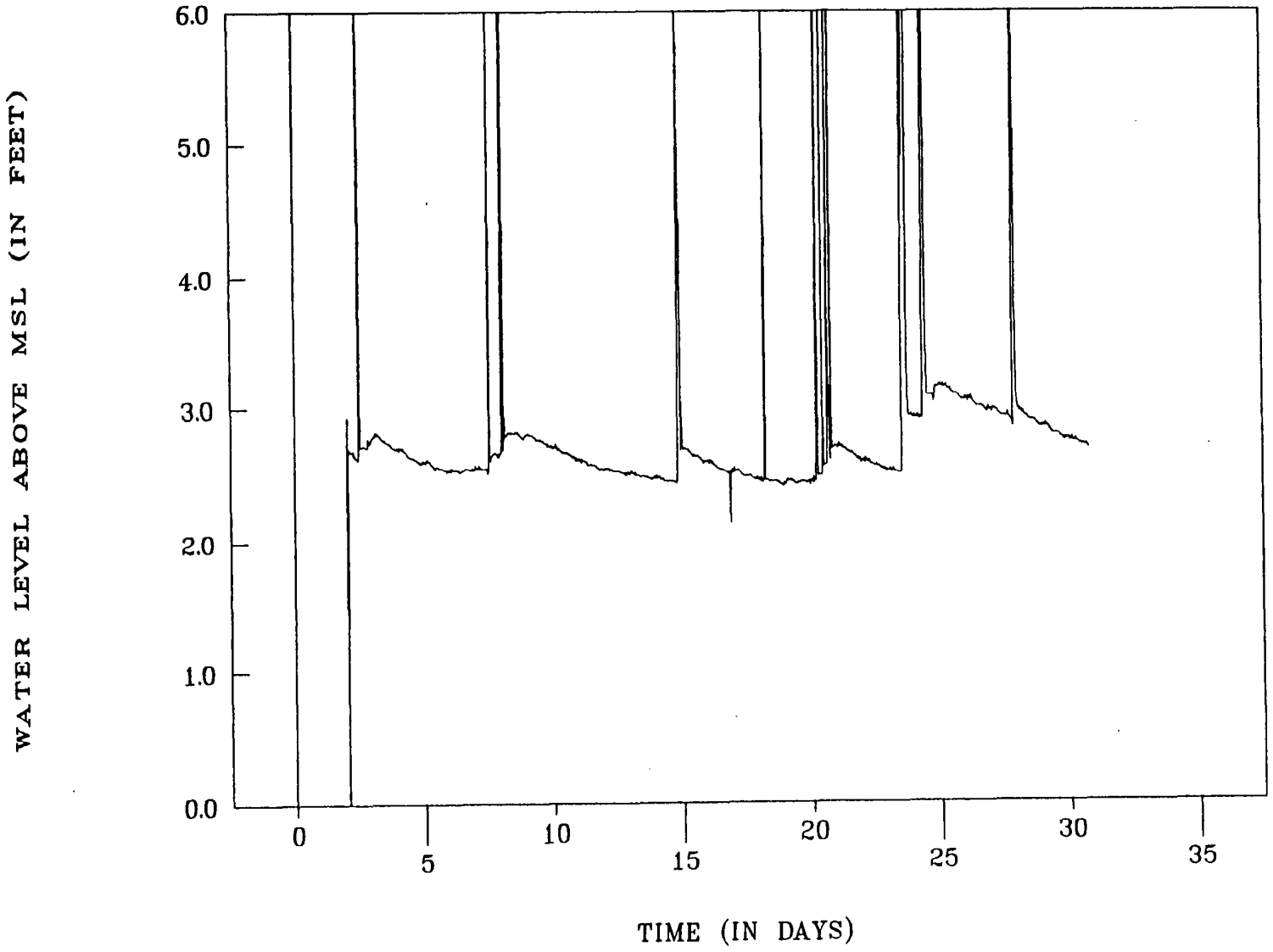
LITTLE CREEK RI/FS

SITE 10 STAFF GAUGE SG3



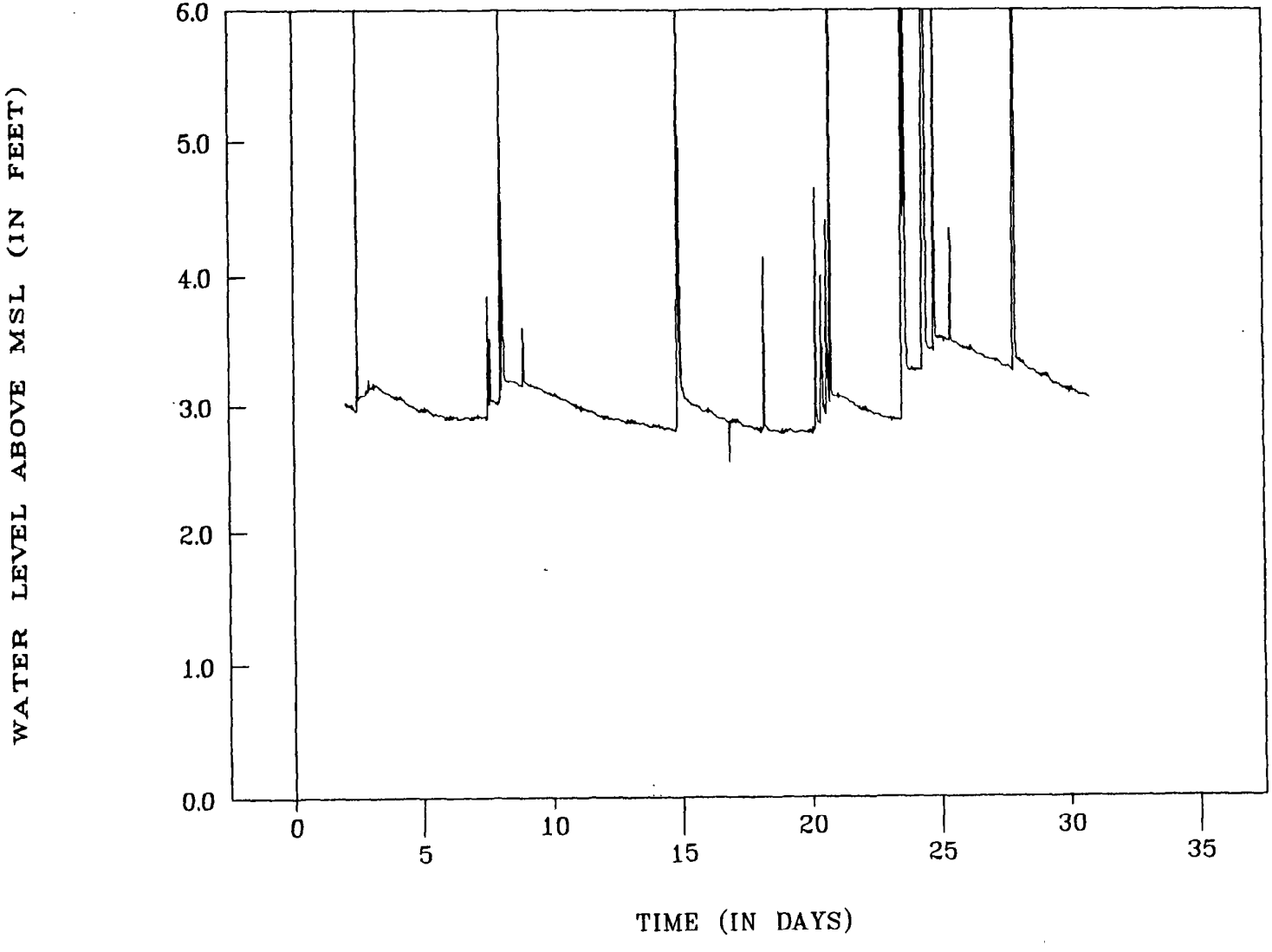
LITTLE CREEK RI/FS

SITE 13 MONITORING WELL GW4



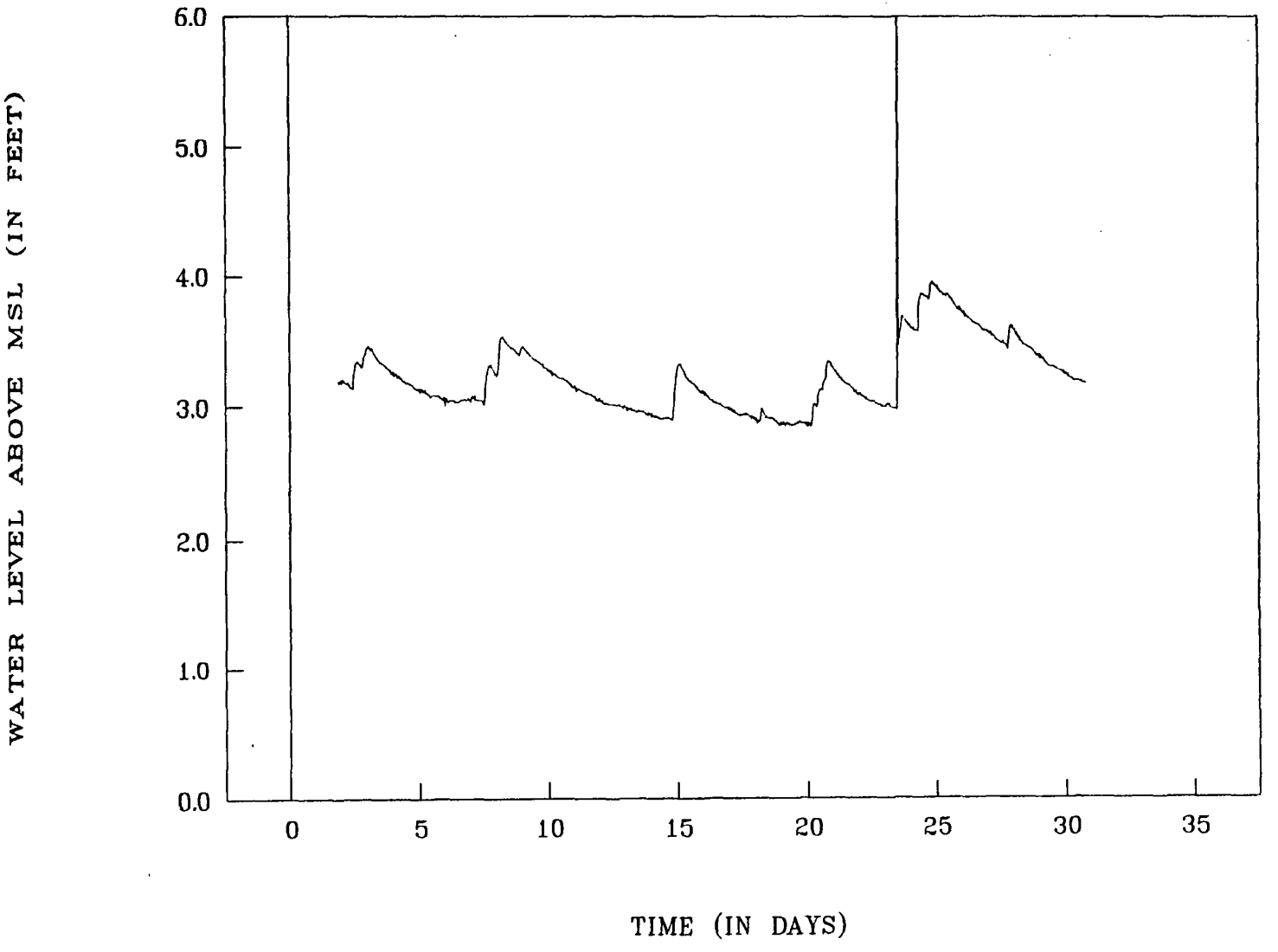
LITTLE CREEK RI/FS

SITE 13 MONITORING WELL GW5



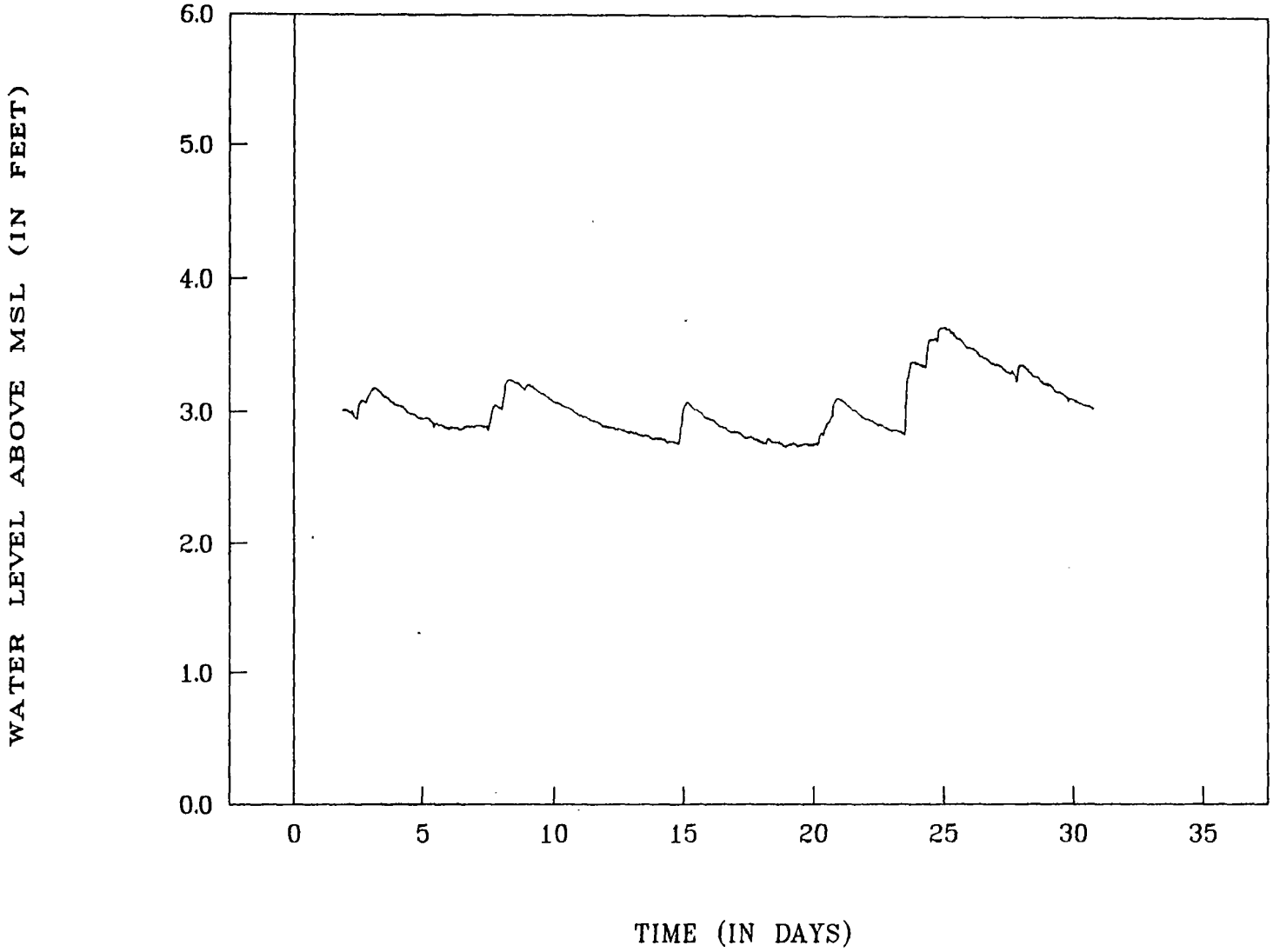
LITTLE CREEK RI/FS

SITE 13 MONITORING WELL GW2



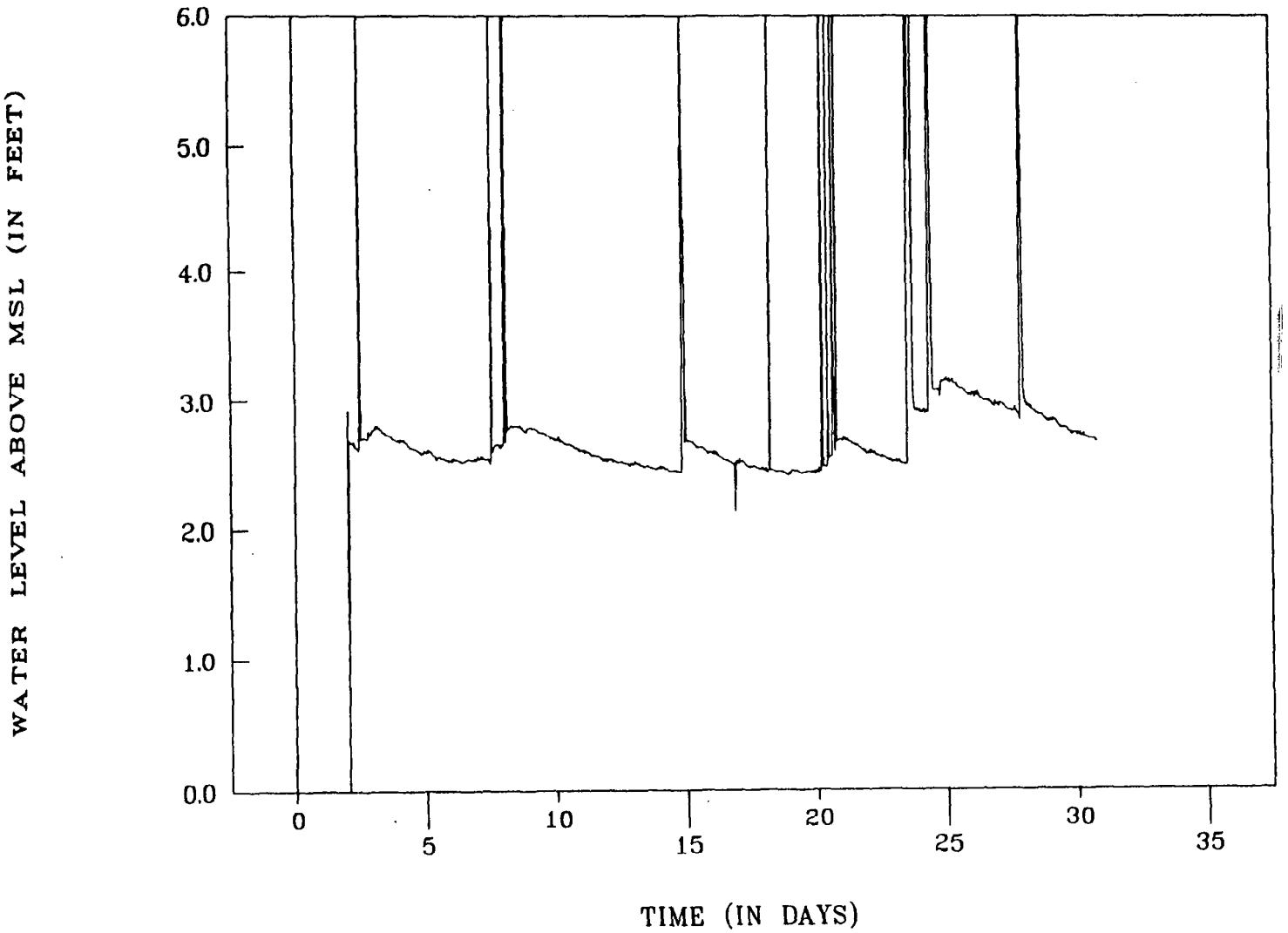
LITTLE CREEK RI/FS

SITE 13 MONITORING WELL GW3



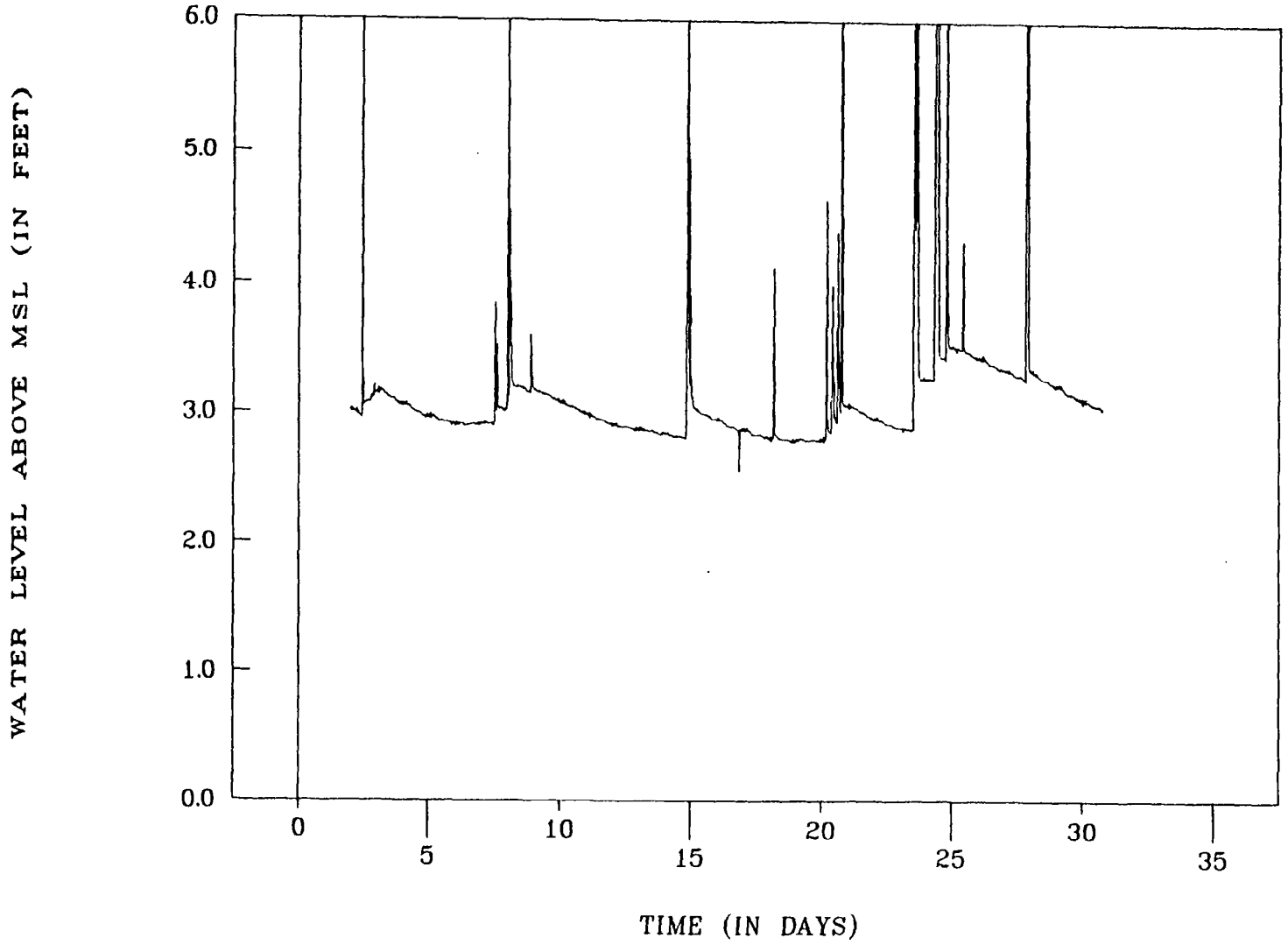
LITTLE CREEK RI/FS

SITE 13 MONITORING WELL GW4



LITTLE CREEK RI/FS

SITE 13 MONITORING WELL GW5



All measurements in feet.

WATER LEVEL FORM

PROJECT: LC NAB - RI/FS MEASURING DEVICE: steel tape & cha

WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
7GW-5 ?or 6	5/11/93	1228	TOC	7.42	11.16
7GW-7	↓	1305	TOC	3.21	11.47
7GW-8	↓	1324	TOC	3.25	11.17
7LCGW 3	↓	1515	TOC	7.12	18.15
7GW-1	↓	1532	TOC	5.71	12.20
9 GW-5	5/12/93	0951	TOC	8.99	20.25
9GW-6	↓	1005	TOC	5.65	17.17
10GW-2	↓	1402	TOC	10.62	20.20
10GW-5	↓	1420	TOC	9.95	20.23
LC13-GW3	5/13/93	0932	TOC	4.13	15.00
LC13-GW2	↓	0940	TOC	2.70?	15.00
LC13-GW5	↓	~~1252~~ 1247	TOC	4.11	14.49
LC13-GW4	↓	1252	TOC	4.63	14.97
	↓	1338	TOC	4.65	14.97

Transcribed - D. Place field notes

WATER LEVEL FORM

PROJECT: LCNAB-RI/FS MEASURING DEVICE: _____

WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
7-GW7	5/25/93	0934	TOC	3.22	—
7-GW8		0934	TOC	3.45	—
7-MW6		1022	TOC	7.67	—
9-MW5		1100	TOC	9.31	—
9-MW6		1107	TOC	5.71	—
10-MW2		1150	TOC	10.82	—
10-MW5		1215	TOC	10.15	—
7MW-1		1310	TOC	5.91	—
7MW-3		1340	TOC	7.95	—
10 MW-6	7/14/93	0715	TOC	9.08	—
~~j~~		~~0730~~	~~TOC~~	~~9.23~~	—
LC10-GW-105		0740	TOC	10.81	—
LC10-GW2		0755		11.72	—
LC10-GW7		0815		10.08	—
LC10-GW1		0835		13.91	—

Transcribed - M. Schmidt field notes

WATER LEVEL FORM

PROJECT: LCNAB - RI/FS MEASURING DEVICE: _____

WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
7GW-5?	6/10/93	0804	TOC	7.78	—
7GW-7		0932	TOC	3.32	—
7GW-8		0940	TOC	3.54	—
9GW-5		1159	TOC	9.14	—
9GW-6		1145	TOC	5.60	—
7GW-1		1351	TOC	5.68	—
7GW-3		1445	TOC	8.17	—
13GW-4	6/11/93	0752	TOC	5.73	—
13GW-5		0748	TOC	4.08	—
13GW-2		~~0819~~ 0822	TOC	4.20	—
13GW-3		~~0822~~ 0819	TOC	4.09	—
10GW-5		0952	TOC	10.06	—
10GW-2		1004	TOC	10.66	—
~~10GW-3~~					

Transcribed - D. Place field n.b.

WATER LEVEL FORM

PROJECT: Little Creek NAB-RI/FS MEASURING DEVICE: EWLI

Site	WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
12	12MW-101	6/28/93	1244	TOC	6.93	12.22
	12MW-102	6/28/93	1248	TOC	5.90	12.89
	12MW-103	6/28/93	1306	TOC	9.85	~~13~~ 15.12
	12MW-104	6/28/93	1301	TOC	9.65	15.32
9	LC9-GW6	6/28/93	1603	TOC	6.23	17.09
	LC9-GW5	6/28/93	1614	TOC	9.71	20.15
	LC9-GW4	6/28/93	1631	TOC	7.38	17.82
	LC9-GW2	6/28/93	1641	TOC	2.31	14.46
	LC9-UST1	6/28/93	1649	TOC	8.09	14.39
	LC9-UST4	6/28/93	1656	TOC	8.72	16.78
	LC9-UST2	6/28/93	1700	TOC	7.17	14.42
	LC9-UST3	6/28/93	1708	TOC	7.69	14.44
10	LC10-GW1	6/28/93	1718	TOC	13.41	13.93
	LC10-GW8	6/28/93	1727	TOC	7.29	20.15
	LC10-GW7	6/28/93	1732	TOC	9.70	18.35
	LC10-GW5	6/28/93	1738	TOC	10.47	20.18
	LC10-GW4	6/28/93	1742	TOC	12.04	19.03
	LC10-GW6	6/28/93	1746	TOC	8.59	18.38
	LC10-GW2	6/28/93	1752	TOC	11.20	19.97
	BMW-8	6/28/93	1806	TOC	4.19	11.46
	BMW-7	6/28/93	N/A	TOC	Could not open outer casing.	

TOC = Top of PVC Casing

[illegible] Water Level Indicator

All meas. in feet

WATER LEVEL FORM

PROJECT: Little Creek NAB-RI/FS MEASURING DEVICE: _____

Site

WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEP WEL
BMW-1	6/29/93	0927	TOC	8.87	12.
BMW-2	6/29/93	0914		2.29	12.
BMW-3	6/29/93	0908		4.80	5.
BMW-4	6/29/93	0908		6.21	12
BMW-5	6/29/93	0843		4.98	12.
BMW-6	6/29/93	0837		6.36	12.

WATER LEVEL FORM

PROJECT: Little Creek NAB-RI/FS MEASURING DEVICE: _____

Site	WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
11	LC11-GW-1	6/29/93		TOC	5.63	17.41
	LC11-GW-2	↓		TOC	4.51	13.18
	LC11-GW-3	↓		TOC	3.98	17.32

WATER LEVEL FORM

PROJECT: LCNAB - RI/FS MEASURING DEVICE: _____

WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
LC11-GW1	6/29/93	0718	TOC	5.63	17.41
LC11-GW2		0724	TOC	4.51	13.18
LC11-GW3		0728	TOC	3.98	17.32 ~~17.39~~
LC13-GW6		0834	TOC	5.04	12.80
LC13-GW7		0909	TOC	5.63	12.93
LC13-GW8		0916	TOC	5.25	12.26
13-GW5		1120	TOC	4.73	14.32
13-GW1		1129	TOC	4.38	14.16
13-GW2		1139	TOC	3.59	14.84
13-GW3		1146	TOC	4.77	14.08
13-GW4		1152	TOC	5.18	14.82
07-GW6		1327	TOC	7.79	19.21
07-GW2		1414	TOC	8.32	18.06
LC7-GW4		1445	TOC	2.03	17.04
LC7-GW3		1454	TOC	9.28	17.98
LC7-GW1		1501	TOC	6.29	12.05
10GW-2	6/30/93	0724	TOC	11.27	—
LC10-GW5		0815	TOC	10.50	—
LC10-GW6		0902	TOC	8.61	—
LC10-GW7		1014	TOC	9.79	—
10-GW1		1050	TOC	13.43	22.08
9-GW4		1408	TOC	8.27	—

[illegible] field note

WATER LEVEL FORM

PROJECT: LCNAB- RI/FS MEASURING DEVICE: _____

WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
12MW-101	6/28/93	1244	TOC	6.93	12.22
12MW-102		1248	TOC	5.90	12.89
12MW-103		1306	TOC	9.85	15.12
12MW-104		1301	TOC	9.65	15.32
~~9UST-3~~	~~6/30/93~~				
LC10-GW01	6/30/93	1050	TOC	13.43	22.08
LC10-GW2		0715	TOC	11.20	19.97
LC10-GW5		0817	TOC	10.50	20.18
LC10-GW06		0905	TOC	8.61	18.38
LC10-GW07		1005	TOC	9.79	18.35
7GW-1	7/1/93	1000	TOC	9.28	17.98
7GW-2		0958	TOC	8.32	18.06
7LC-GW3		0850	TOC	9.28	17.98
7GW-4		1021	TOC	2.03	17.04
7C7-6		1219	TOC	7.79	19.21
LC7-7		0715	TOC	3.41	11.42
LC7-8		0715	TOC	4.41	11.12
LC7-GW9		1034	TOC	4.28	11.50

WATER LEVEL FORM

PROJECT: LCNAB- RI/FS MEASURING DEVICE: _____

WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
7-GW7	7/1/93	0715	TOC	3.41	11.42
7-GW8	↓	0715	TOC	4.41	11.12
7-GW9	↓	1034	TOC	4.28	11.50
BMW-1	7/2/93	0733	TOC	6.28	12.57

WATER LEVEL FORM

PROJECT: LCNAB-RI/FS MEASURING DEVICE: _____

WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
13-MW3	7/29/93	1520	TOC	5.75	14.08
13-MW4		1635	TOC	5.67	14.82
13-MW5		1735	TOC	5.35	14.32
13-MW6		1550	TOC	5.50	12.80
13-MW7		1710	TOC	6.20	12.93
13-MW8		1430	TOC	5.83	12.26
7-MW5		—	TOC	6.50	16.30

WATER LEVEL FORM

PROJECT: Little Creek NAB-RI/FS MEASURING DEVICE: _____

Site	WELL #	DATE	TIME	MEASURING POINT (M.P.)	DEPTH TO WATER FROM M.P.	DEPTH OF WELL FROM M.P.
	BMW-6	6/29/93	0837	TOC	6.36	12.41
	BMW-5	6/29/93	0843	TOC	4.98	12.60
Lock	BMW-4	6/29/93	0857	TOC	6.21	12.53
	BMW-3	6/29/93	0908	TOC	4.80	5.45
	BMW-2	6/29/93	0914	TOC	2.29	12.64
Lock	BMW-1	6/29/93	0927	TOC	8.87	12.52
	BMW-29	6/29/93	0948	TOC	4.15	12.15
Container	LC5-3	6/29/93	1024	TOC	6.16	18.96
	LC5-4	6/29/93	1029	TOC	6.73	15.27
Far	LC5-1	6/29/93	1032	TOC	10.21	22.23
Near	LC5-2	6/29/93	1034	TOC	11.17	22.41
7	7	6/29/93	1115	TOC	3.41	11.42
	8	6/29/93	1133	TOC	4.41	11.12
	LC13-GW3	7/29/93	1520	TOC	5.75	14.08
	LC13-GW4	↓	1635	TOC	5.67	14.82
	LC13-GW5		1735	TOC	5.35	14.32
	LC13-GW6		1550	TOC	5.50	12.80
	LC13-GW7		1710	TOC	6.20	12.93
	LC13-GW8		1430	TOC	5.83	12.26

→ DT oil

APPENDIX E

Surface Soil Sample Descriptions

SURFACE SOIL SAMPLE DESCRIPTIONS

SURFACE SOIL SAMPLE NUMBER	SURFACE SOIL SAMPLE DESCRIPTION
07SS-101	Bare spot off small road in the "ear" of the landfill: 1" brown silty F SAND with some organics, then brown-orange silty F SAND with fill material.
07SS-102	South side of landfill between dirt road and tree line: 1" brown silty F SAND with some organics, then brown-orange silty F SAND with fill material and some GRAVEL.
07SS-103	Middle of second island in landfill road, heading east: greyish-brown silty F SAND with GRAVEL
07SS-104	Island in landfill road by Helicopter Road: greyish-brown silty F SAND with gravel. Fragments of black beauty on the soil surface.
07SS-105	Northeast portion of the leveled fill area: tan silty M-F SAND.
07SS-106	Middle of north side of fill area, beyond the base of the new fill: brown silty F SAND.
07SS-107	Northwest corner of fill area, beyond base of new fill: 4" of dark grey silty F SAND, then white M-F SAND.
07SS-108	Portion of fill area south of Amphibious Drive, approximately 60 feet west of the sewage treatment plant and approximately 50 feet from Amphibious Drive: 2" of brown silty F SAND, then light grey F sandy CLAY.
07SS-109 (Duplicate of 07SS-102)	South side of landfill between dirt road and tree line: 1" brown silty F SAND with some organics, then brown-orange silty F SAND with fill material and some GRAVEL.
09SS-101	200' east, 134' south of north fence/parking lot corner: 0 - 1/2" is silty, clayey SAND crust, then 1/2 - 3" clayey SAND.
09SS-102	140' east, 77' north of south fence/parking lot corner: 0 - 2" is clayey, silty light brown SAND grading into F SAND with cobbles.

SURFACE SOIL SAMPLE DESCRIPTIONS

SURFACE SOIL SAMPLE NUMBER	SURFACE SOIL SAMPLE DESCRIPTION
09SS-103	316' east, 173' north of south fence/parking lot corner: 0 - 1/2" is silty CLAY crust, then brown-orange silty sandy CLAY.
09SS-104	380' east, 23' south of north fence/parking lot corner: 0 - 3" is brown F - C SAND.
09SS-105	648' east, 168' south of north fence/parking lot corner: 0 - 1/2" is silty CLAY crust, then brown-orange silty sandy CLAY with some cobbles.
09SS-106	747' east, 15' north of south fence/parking lot corner: surface covered with 1/8" diameter cylindrical black pellets, then 2" brown silty F SAND grading into a F - M SAND with organics.
09SS-107 (Duplicate of 09SS-102)	140' east, 77' north of south fence/parking lot corner: 0 - 2" is clayey, silty light brown SAND grading into F SAND with cobbles.
10SS-101	Center of infield, 175' straight out from center of back-stop behind home plate, northern ball field: 2" hard packed grey silty F SAND, then trace organics, the 1" brown F - M SAND with some fines.
10SS-102	12' east, 37' north of northeast corner of west dugout, northern ball field: 1" hard packed grey silty F SAND, then 2" brown-orange CLAY with 1/2" lens of F - M SAND.
10SS-103	21' west, 8' south of southwest corner of west dugout, southern ball field: 1" hard packed silty F SAND with some S - M GRAVEL, then 2" brown-orange CLAY.
10SS-104	22' northwest, 10' northeast of northeast corner of ball field maintenance building: 1" hard packed silty F - C SAND, then 2" brown-orange extremely hard packed CLAY.
10SS-105	50' north of center of access gate inside combat training area: 3" dark grey F - C SAND with trace S - M GRAVEL , slightly damp.

SURFACE SOIL SAMPLE DESCRIPTIONS

SURFACE SOIL SAMPLE NUMBER	SURFACE SOIL SAMPLE DESCRIPTION
10SS-106	96' west, 10' south of east corner of northern ball field: 1" light brown CLAY, then 2" brown-orange CLAY.
10SS-107	50' northeast of light pole behind north ball field: 2" silty F SAND, then 2" F - M SAND with trace of fines and some organics.
10SS-108	184' east, 12' south of east corner of northern ball field: 2" silty F SAND with some M - C GRAVEL, then 1" brown-orange CLAY.
10SS-109 (Duplicate of 10SS-102)	12' east, 37' north of northeast corner of west dugout, northern ball field: 1" hard packed grey silty F SAND, then 2" brown-orange CLAY with 1/2" lens of F - M SAND.
11SS-101	Just north of monitoring well 11-GW01: dark brown-grey sandy loam with a large amount of organic material.
11SS-102	South side of Building 3651, center: dark brown-grey sandy loam with a large amount of organic material.
11SS-103	Northeast side of dry well: dark brown-grey sandy loam with a large amount of organic material.
11SS-104	Northwest side of dry well: dark brown-grey sandy loam with a large amount of organic material.
11SS-105	In bottom of drainage ditch, near storm sewer outfall pipe: dark brown-grey sandy silty loam with a large amount of organic material.
11SS-106	In bottom of drainage ditch, equidistant from 11SS-105 and drainage ditch storm water drain: dark brown-grey sandy silty loam with a large amount of organic material.
11SS-107	In bottom of drainage ditch, 1' east of drainage ditch storm sewer drain: dark brown-grey sandy silty loam with a large amount of organic material.

SURFACE SOIL SAMPLE DESCRIPTIONS

SURFACE SOIL SAMPLE NUMBER	SURFACE SOIL SAMPLE DESCRIPTION
11SS-108	Immediately adjacent to sidewalk and door to Building 3651: dark brown-grey sandy loam with a large amount of organic material.
11SS-109	7' southeast of steam vent, in back of Building 3651: dark brown-grey sandy loam with a large amount of organic material.
11SS-110	South side of Building 3651, towards northeast corner: dark brown-grey sandy loam with a large amount of organic material.
11SS-111 (Duplicate of 11SS-105)	In bottom of drainage ditch, near storm sewer outfall pipe: dark brown-grey sandy silty loam with a large amount of organic material.
13SS-101	21' east, 3' south of southwest corner of fenced area to the west of Building 3165E: top 1/4" organics, then next 1/2" F - M SAND with fines, then brown silty F SAND with some organics.
13SS-102	1.5' west, 19' south of southwest corner of fenced area to the west of Building 3165E: top 2" F - M SAND with fines (not sampled), then brown silty F - M SAND with F - M GRAVEL (sampled).
13SS-103	2' east, 4' south of access gate to fenced area to the west of Building 3165E: top 2" top soil with grass (not sampled), then hard packed silty F SAND with F - M GRAVEL (sampled).
13SS-104	5' west, 15' north of northeast corner of fenced storage area, west side of site: top 3" top soil with grass (not sampled), then dark brown silty sandy CLAY, then brown CLAY.
13SS-105	48' west, 18' north of northeast corner of fenced storage area, west side of site: top 3" top soil with grass (not sampled), then dark brown silty sandy CLAY, then brown CLAY.
13SS-106 (Duplicate of 13SS-103)	2' east, 4' south of access gate to fenced area to the west of Building 3165E: top 2" top soil with grass (not sampled), then hard packed silty F SAND with F - M GRAVEL (sampled).

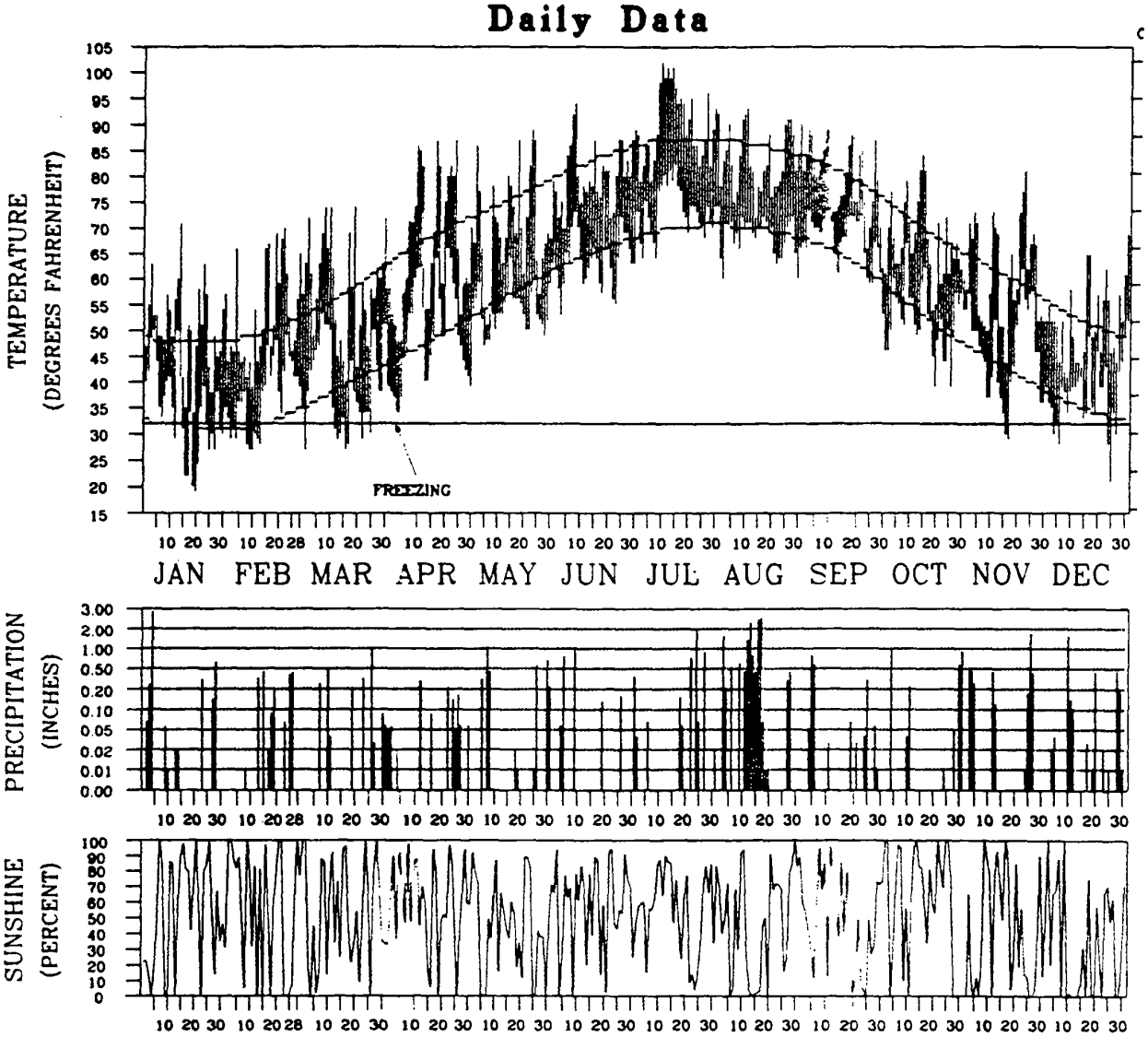
APPENDIX F

Climatological Data

ISSN 0198

1992 LOCAL CLIMATOLOGICAL DATA
ANNUAL SUMMARY WITH COMPARATIVE DATA
NORFOLK, VIRGINIA

Daily Data



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

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

Kenneth D. Wadee
DIRECTOR
NATIONAL CLIMATIC DATA CENTER

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

METEOROLOGICAL DATA FOR 1992

NORFOLK, VIRGINIA

LATITUDE: 36°54' N LONGITUDE: 76°12' W ELEVATION: FT. GRND 24 BARO 44 TIME ZONE: EASTERN WBAN: 13737

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F:													
Averages													
-Daily Maximum	51.1	53.1	58.8	68.[illegible]	70.7	80.6	90.4	83.2	80.2	67.6	[illegible]	51.8	68.1
-Daily Minimum	34.3	36.8	38.7	48.[illegible]	54.0	63.3	73.2	68.0	66.8	51.7	[illegible]	37.4	51.5
-Monthly	42.7	45.0	48.8	58.[illegible]	62.4	72.0	81.8	75.6	73.5	59.7	[illegible]	44.6	59.8
-Monthly Dewpt.	31.9	33.9	34.1	44.[illegible]	52.5	61.8	70.2	67.6	64.8	49.1	[illegible]	35.8	49.3
Extremes													
-Highest	71	70	74	8[illegible]	89	94	102	93	89	84	81	69	102
-Date	14	22	19	24	23	8	10	11	18	15	23	31	JUL 10
-Lowest	19	27	27	3[illegible]	47	53	64	60	53	39	29	21	19
-Date	20	10	16	[illegible]	5	3	8	30	30	26	[illegible]	25	JAN 20
DEGREE DAYS BASE 65 °F:													
Heating	686	575	496	262	125	1	0	0	9	179	337	623	3293
Cooling	0	0	0	63	51	220	527	336	270	23	9	0	1499
% OF POSSIBLE SUNSHINE	53	57	53	[illegible]	44	59	54	48	48	60	[illegible]	34	51
AVG. SKY COVER (tenths)													
Sunrise - Sunset	6.5	6.2	6.0	5.[illegible]	6.6	6.4	6.1	6.7	7.0	4.9	[illegible]	7.7	6.4
Midnight - Midnight	6.2	5.5	5.7	5.[illegible]	6.5	6.3	5.8	6.5	6.5	4.7	[illegible]	7.2	6.1
NUMBER OF DAYS:													
Sunrise to Sunset													
-Clear	8	7	8	[illegible]	4	6	7	4	4	15	8	5	83
-Partly Cloudy	6	7	10	12	14	11	11	13	13	6	6	4	113
-Cloudy	17	15	13	1[illegible]	13	13	13	14	13	10	16	22	170
Precipitation .01 inches or more	10	9	9	1[illegible]	9	5	10	16	10	7	9	13	118
Snow, Ice pellets, hail 1.0 inches or more	0	0	0	0	0	0	0	0	0	0	0	0	0
Thunderstorms	0	1	2	3	2	2	10	7	3	1	1	0	32
Heavy Fog, visibility 1/4 mile or less	1	4	2	2	2	0	0	0	3	3	3	3	23
Temperature °F													
-Maximum													
90° and above	0	0	0	0	0	2	15	8	0	0	0	0	25
32° and below	0	0	0	0	0	0	0	0	0	0	0	0	0
-Minimum													
32° and below	13	9	8	[illegible]	0	0	0	0	0	0	2	6	39
0° and below	0	0	0	0	0	0	0	0	0	0	0	0	0
AVG. STATION PRESS. (mb)	1015.6	1015.9	1014.6	1015.6	1016.9	1012.9	1014.2	1018.0	1019.3	1018.0	1020.0	1019.6	1016.6
RELATIVE HUMIDITY (%)													
Hour 01	74	74	65	76	85	86	83	90	86	80	81	77	80
Hour 07 (Local Time)	77	77	73	74	81	80	82	86	84	80	80	78	79
Hour 13	57	59	50	48	61	59	55	63	63	56	60	64	58
Hour 19	68	67	60	60	70	67	70	77	78	74	76	72	70
PRECIPITATION (inches):													
Water Equivalent													
-Total	4.48	2.07	2.63	1.26	3.46	2.22	4.52	14.32	2.06	2.85	4.26	3.15	47.28
-Greatest (24 hrs)	3.14	0.82	1.05	0.32	1.32	1.04	2.01	2.59	1.42	1.54	1.95	1.76	3.14
-Date	3-4	25-26	26	12	7-8	9	24	17-18	5-6	30-31	25-26	10-11	JAN 3-4
Snow, Ice pellets, hail													
-Total	T	0.0	T	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T
-Greatest (24 hrs)	T	0.0	T	T	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	T
-Date	19		27	5									APR 5
WIND:													
Resultant													
-Direction (!!!)	286	339	287	195	049	103	221	105	044	001	022	315	354
-Speed (mph)	2.9	3.3	1.4	1.[illegible]	5.7	1.4	4.4	0.9	4.0	2.2	1.6	3.6	1.0
Average Speed (mph)	11.1	11.3	11.8	11.[illegible]	11.2	8.4	9.3	7.0	10.5	9.8	9.2	10.9	10.2
Fastest Obs. 1 Min.													
-Direction (!!!)	30	36	26	24	05	36	27	18	04	04	21	32	26
-Speed (mph)	29	29	37	23	32	21	35	28	32	35	25	32	37
-Date	16	29	27	24	7	22	27	28	24	5	12	24	MAR 27
Peak Gust													
-Direction (!!!)	W	N	W	SW	NE	N	W	SW	NE	NE	[illegible]	NW	NE
-Speed (mph)	47	40	55	44	45	29	48	48	55	49	[illegible]	48	55
-Date	14	29	27	24	7	21	18	28	25	5	[illegible]	24	SEP 25

(!!!) See Reference Notes on Page 6B

NORMALS, MEANS, AND EXTREMES

NORFOLK, VIRGINIA

LATITUDE: 36°54'N LONGITUDE: 76°12'W ELEVATION: FT. GRND 24 BARO 44 TIME ZONE: EASTERN WBAN: 1373

	(a)	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE °F:														
Normals														
-Daily Maximum		48.1	45.9	57.5	68.2	75.7	83.2	86.9	85.7	80.2	69.8	60.8	51.9	68.
-Daily Minimum		31.7	32.3	39.4	48.1	57.2	65.3	69.9	69.6	64.2	52.8	43.0	35.0	50.
-Monthly		39.9	41.1	48.5	58.2	66.4	74.3	78.4	77.7	72.2	61.3	51.9	43.5	59.
Extremes														
-Record Highest	44	78	81	88	97	100	101	103	104	99	95	86	80	10
-Year		1970	1989	1990	1960	1991	1964	1952	1980	1983	1954	1974	1991	AUG 198
-Record Lowest	44	-3	8	18	28	36	45	54	49	45	27	20	7	-
-Year		1985	1965	1980	1982	1966	1967	1979	1982	1967	1976	1950	1983	JAN 198
NORMAL DEGREE DAYS:														
Heating (base 65°F)		778	669	512	219	53	0	0	0	9	146	393	667	344
Cooling (base 65°F)		0	0	0	15	96	282	415	394	225	31	0	0	145
% OF POSSIBLE SUNSHINE	28	55	57	61	63	63	67	63	62	62	60	57	56	6
MEAN SKY COVER (tenths)														
Sunrise - Sunset	44	6.3	6.2	6.1	5.8	6.1	5.8	6.0	5.9	5.7	5.4	5.5	6.1	5.
MEAN NUMBER OF DAYS:														
Sunrise to Sunset														
-Clear	44	9.0	8.1	8.9	8.8	7.8	7.6	7.4	7.7	9.0	11.7	10.4	9.3	105.
-Partly Cloudy	44	6.6	6.2	7.6	9.2	10.0	11.8	11.8	12.0	9.6	7.1	8.0	7.0	106.
-Cloudy	44	15.5	13.9	14.5	12.0	13.2	10.7	11.8	11.3	11.4	12.2	11.6	14.7	152.
Precipitation .01 inches or more	44	10.5	10.3	10.9	10.0	9.9	9.2	11.2	10.6	7.9	7.5	8.0	9.1	115.
Snow, Ice pellets, hail 1.0 inches or more	44	0.8	0.7	0.2	0.*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.
Thunderstorms	44	0.4	0.7	1.9	2.8	4.8	5.8	8.4	7.0	2.6	1.3	0.5	0.4	36.
Heavy Fog Visibility 1/4 mile or less	44	2.2	2.6	1.9	1.4	1.9	1.0	0.5	1.1	1.2	2.3	1.8	2.2	20.
Temperature °F														
-Maximum														
90° and above	44	0.0	0.0	0.0	0.5	1.6	6.6	11.7	8.8	2.8	0.1	0.0	0.0	32.
32° and below	44	2.6	1.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	4.
-Minimum														
32° and below	44	16.5	14.1	6.2	0.3	0.0	0.0	0.0	0.0	0.0	0.1	3.1	13.3	53.
0° and below	44	0.*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AVG. STATION PRESS. (mb)	20	1018.3	1016.0	1016.4	1015.0	1015.0	1015.0	1015.7	1016.7	1017.6	1018.7	1018.8	1019.3	1017.
RELATIVE HUMIDITY (%)														
Hour 01	44	73	72	72	73	81	83	84	86	84	82	76	73	7
Hour 07 (Local Time)	44	74	74	74	73	77	79	82	84	83	82	79	75	7
Hour 13 (Local Time)	44	58	56	54	50	56	56	59	61	61	59	56	58	5
Hour 19 (Local Time)	44	67	66	62	61	66	67	70	74	75	74	70	68	6
PRECIPITATION (inches):														
Water Equivalent														
-Normal		3.72	3.26	3.86	2.87	3.75	3.45	5.15	5.33	4.35	3.41	2.88	3.17	45.2
-Maximum Monthly	44	9.93	6.23	8.50	7.25	10.12	9.72	13.73	14.32	13.80	10.12	7.01	6.10	14.3
-Year		1987	1983	1989	1984	1979	1963	1975	1992	1979	1971	1951	1983	AUG 199
-Minimum Monthly	44	1.05	1.64	0.75	0.43	0.64	0.37	0.77	0.74	0.26	0.57	0.49	0.67	0.2
-Year		1981	1961	1986	1985	1991	1954	1983	1975	1986	1984	1965	1988	SEP 198
-Maximum in 24 hrs	44	3.80	[illegible]	3.18	5.90	3.41	6.85	5.64	11.40	6.79	4.38	3.35	2.76	11.4
-Year		1967	1983	1958	1991	1980	1963	1969	1964	1959	1971	1952	1983	AUG 196
Snow, Ice pellets, hail														
-Maximum Monthly	44	14.2	24.4	13.7	1.2	0.0	T	0.0	T	0.0	0.0	0.6	14.7	24.
-Year		1966	1989	1980	1964		1990		1991			1950	1958	FEB 198
-Maximum in 24 hrs	44	9.1	12.5	9.9	1.2	0.0	T	0.0	T	0.0	0.0	0.6	11.4	14.
-Year		1973	1983	1980	1964		1990		1991			1950	1958	FEB 198
WIND:														
Mean Speed (mph)	44	11.5	11.9	12.5	11.8	10.5	9.8	9.0	8.8	9.7	10.3	10.6	11.1	10.
Prevailing Direction through 1963		SW	WNW	SW	SW	SW	SW	SW	SW	NE	NE	SW	SW	SW
Fastest Obs. 1 Min.														
-Direction (!!!)	20	23	34	22	02	28	30	34	35	30	04	21	01	0
-Speed (MPH)	20	39	44	46	41	38	46	46	46	46	48	40	39	4
-Year		1978	1973	1973	1990	1989	1977	1973	1979	1985	1982	1989	1989	OCT 198
Peak Gust														
-Direction (!!!)	9	N	E	W	N	NW	SW	N	E	NW	N	E	N	
-Speed (mph)	9	58	56	62	56	66	69	63	63	67	69	55	53	6
-Date		1987	1983	1989	1990	1984	1987	1986	1986	1985	1990	1985	1989	OCT 199

(!!!) See Reference Notes on Page 6B.

PRECIPITATION (inches)

NORFOLK, VIRGINIA

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1963	3.36	3.75	2.98	1.29	1.55	9.72	2.01	2.40	6.84	1.21	5.31	2.85	43.27
1964	4.56	4.56	2.26	2.38	1.56	2.88	7.33	10.58	12.26	5.55	1.14	2.95	57.71
1965	2.73	2.53	2.83	2.24	1.48	4.89	3.46	3.08	0.77	1.29	0.49	1.08	26.67
1966	3.86	3.83	1.50	1.68	5.95	1.82	4.26	5.24	3.39	1.25	1.05	3.13	37.96
1967	5.44	3.56	1.34	1.31	3.25	1.37	7.21	11.19	3.02	0.93	1.75	4.84	45.21
1968	3.62	2.01	4.76	3.17	2.16	3.07	4.23	2.04	1.51	4.44	3.56	3.14	37.71
1969	1.26	2.16	4.88	2.07	2.05	4.13	12.70	5.28	2.72	3.18	2.97	3.93	48.33
1970	2.27	3.97	3.37	3.19	2.58	4.10	5.33	2.04	1.72	1.30	2.34	3.01	35.22
1971	4.03	3.59	3.88	2.18	4.46	2.16	4.81	4.63	5.46	10.12	0.97	1.44	47.73
1972	2.94	3.50	2.55	2.15	3.35	4.93	4.65	1.60	6.91	4.09	5.44	4.12	46.23
1973	2.54	3.21	4.69	3.44	3.62	5.93	4.19	7.92	0.86	1.37	1.90	5.83	45.50
1974	3.52	2.98	5.16	3.34	3.74	4.76	5.47	8.33	4.40	1.23	1.22	3.81	47.96
1975	4.18	4.18	5.72	4.19	3.37	1.16	13.73	0.74	4.82	3.19	1.63	3.62	50.53
1976	2.51	1.50	2.21	0.99	3.74	1.55	5.19	2.62	3.51	2.90	2.38	3.22	32.36
1977	3.33	2.23	4.05	2.20	3.86	2.41	2.70	4.57	3.00	6.09	5.41	3.92	43.77
1978	4.32	1.91	7.80	2.90	5.64	7.84	4.19	1.66	1.17	1.50	4.40	2.31	47.64
1979	6.47	5.01	5.13	7.00	10.12	2.97	4.69	1.79	13.80	1.74	5.26	0.98	64.96
1980	4.54	2.91	4.40	3.25	5.17	1.39	1.85	4.54	1.47	4.21	2.01	2.64	38.38
1981	1.05	2.26	1.88	2.26	2.75	5.10	5.10	6.87	3.18	3.28	1.78	5.77	41.18
1982	3.35	5.81	3.04	1.71	3.07	4.22	5.83	6.51	3.63	4.25	3.43	4.30	49.15
1983	2.21	6.23	4.55	6.13	3.52	3.84	0.77	3.07	4.52	5.29	3.24	6.10	49.47
1984	2.77	4.66	5.09	7.25	6.23	1.50	7.66	2.25	1.94	0.57	2.68	2.22	44.82
1985	3.98	3.53	2.02	0.43	3.23	6.87	6.14	1.89	6.36	3.92	5.71	0.79	44.81
1986	2.52	2.71	0.75	3.31	1.41	1.51	2.59	4.80	0.26	1.67	1.21	3.74	26.48
1987	3.93	3.11	2.30	3.83	2.65	2.98	3.20	2.04	7.00	1.81	3.51	2.33	44.69
1988	3.12	2.70	2.11	3.53	5.49	3.83	2.93	5.69	1.74	2.85	4.02	0.67	38.68
1989	2.70	5.80	8.50	3.62	2.97	5.10	4.86	7.49	5.10	2.94	3.69	3.86	56.63
1990	3.26	2.93	3.49	3.55	3.79	3.51	4.06	11.85	1.00	3.73	1.68	2.67	45.52
1991	4.74	0.84	4.70	6.39	0.64	4.54	6.46	3.77	2.04	4.65	1.72	2.43	42.92
1992	4.48	2.07	2.63	1.26	3.46	2.22	4.52	14.32	2.06	2.85	4.26	3.15	47.28
Record Mean	3.36	3.35	3.74	3.24	3.69	3.93	5.58	5.38	3.83	3.13	2.67	3.19	45.14

See Reference Notes on Page 6B.

AVERAGE TEMPERATURE (deg. F)

NORFOLK, VIRGINIA

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	ANNUAL
1963	37.1	35.7	53.4	60.3	64.6	73.2	77.0	76.7	66.7	60.1	52.0	35.2	57.7
1964	42.3	39.9	49.5	55.2	66.4	74.5	77.3	74.4	70.8	57.7	54.6	46.5	59.1
1965	39.7	41.0	44.4	54.5	69.7	72.9	76.7	77.1	73.6	59.0	51.6	43.5	58.6
1966	35.8	38.6	47.9	54.5	63.6	71.6	78.0	74.9	69.9	59.3	50.5	41.4	57.1
1967	45.7	39.9	47.7	58.0	61.2	71.2	76.3	75.2	66.5	58.7	45.9	44.0	57.5
1968	34.8	34.0	50.0	55.1	64.6	74.9	78.0	80.5	71.5	63.1	52.9	41.4	58.4
1969	38.5	39.8	44.7	59.8	67.4	77.1	79.2	76.2	71.1	62.2	49.1	40.9	58.9
1970	33.9	39.3	44.7	56.7	67.5	74.9	76.9	78.0	74.7	63.7	51.7	47.0	59.1
1971	35.6	44.7	46.9	55.9	65.0	76.0	77.2	75.7	73.2	66.7	52.4	52.3	60.4
1972	46.4	43.2	49.0	56.4	63.5	70.5	77.6	75.8	71.9	59.2	51.6	49.2	59.5
1973	40.5	39.7	52.3	58.5	66.9	76.9	78.3	78.5	75.0	64.2	53.5	46.2	60.9
1974	42.6	43.4	53.1	60.8	66.8	72.9	78.3	77.4	71.4	58.7	53.5	46.0	60.9
1975	46.0	45.4	47.4	52.7	68.3	77.0	78.6	79.6	72.3	63.4	55.7	43.2	60.8
1976	32.9	49.9	53.4	61.9	66.3	75.9	78.2	75.9	71.1	57.7	45.9	41.4	59.7
1977	29.2	41.5	54.7	61.9	68.2	74.3	81.4	81.0	76.3	60.5	54.8	43.5	60.6
1978	37.0	32.6	46.1	57.2	65.6	74.1	76.1	80.5	73.2	60.8	56.0	45.3	58.7
1979	39.4	33.3	49.1	58.1	66.7	70.4	77.1	78.5	72.8	60.4	56.4	44.9	58.9
1980	40.3	34.7	46.5	58.6	67.8	73.9	80.9	80.9	76.1	60.4	49.9	42.3	59.4
1981	32.7	43.1	45.4	61.2	65.1	78.3	79.8	75.1	70.7	59.6	50.7	41.0	58.6
1982	35.4	42.0	48.8	55.0	69.4	73.4	78.6	75.3	70.0	60.2	54.4	48.8	59.3
1983	40.2	40.8	51.0	55.7	65.8	73.0	80.3	79.0	72.8	62.7	52.6	41.6	59.6
1984	35.5	46.7	45.4	55.6	67.8	76.2	76.7	78.4	70.5	66.9	49.9	50.9	60.0
1985	34.9	40.4	51.8	62.0	68.8	74.2	78.2	77.2	73.4	65.9	60.3	41.2	60.7
1986	39.3	42.1	49.9	57.3	67.6	76.1	82.1	76.6	72.4	65.4	54.9	44.8	60.7
1987	39.6	38.7	47.5	54.6	68.3	77.0	82.4	79.6	74.3	56.6	54.3	46.0	59.9
1988	37.3	42.5	49.5	56.5	65.8	73.6	80.1	80.8	70.5	56.9	54.2	42.4	59.2
1989	45.3	43.6	50.1	56.5	65.6	78.5	79.2	77.7	73.9	62.7	53.3	34.8	60.1
1990	47.3	50.2	53.2	58.7	66.6	75.5	80.6	78.0	71.6	65.9	55.0	50.5	62.8
1991	43.5	46.0	52.7	61.6	72.8	76.2	82.0	79.5	72.3	61.9	52.7	47.6	62.4
1992	42.7	45.0	48.8	58.2	62.4	72.0	81.8	75.6	73.5	59.7	53.8	44.6	59.8
Record Mean	41.2	42.2	48.9	57.5	66.8	74.7	78.8	77.6	72.5	62.1	52.3	43.7	59.8
Max	49.0	50.5	57.8	66.9	75.8	83.3	86.9	85.1	79.8	69.9	60.3	51.4	68.1
Min	33.3	33.9	40.0	48.1	57.7	66.0	70.6	70.0	65.1	54.3	44.2	35.9	51.6

See Reference Notes on Page 6B.

HEATING DEGREE DAYS Base 65 deg. F NORFOLK, VIRGINIA

SEASON	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	TOTAL
1963-64	0	0	44	156	384	920	697	719	482	303	108	4	381
1964-65	0	0	4	232	312	575	780	667	635	320	29	15	3569
1965-66	0	6	1	195	398	657	897	734	527	330	121	21	3887
1966-67	0	0	22	191	437	725	588	699	533	244	157	21	3617
1967-68	0	0	36	211	566	644	928	895	471	294	88	0	4133
1968-69	0	0	0	124	361	726	814	697	624	192	44	0	3582
1969-70	0	0	8	131	469	741	960	714	622	263	57	0	3965
1970-71	0	0	16	93	393	552	812	567	555	269	69	0	3326
1971-72	0	0	3	27	391	390	572	628	494	272	81	11	2869
1972-73	0	0	4	197	406	486	752	703	403	217	47	0	3215
1973-74	0	0	0	83	353	575	504	599	377	183	63	0	2737
1974-75	0	0	16	213	371	584	584	547	541	382	47	0	3285
1975-76	0	0	6	98	290	671	804	443	362	186	62	6	2928
1976-77	0	0	0	245	566	726	1104	657	330	150	40	1	3819
1977-78	0	0	0	158	321	661	860	902	580	235	72	3	3792
1978-79	0	0	3	162	268	614	787	879	499	213	52	5	3482
1979-80	0	0	0	190	272	616	759	872	564	196	58	2	3529
1980-81	0	0	11	181	449	699	994	610	605	159	96	0	3804
1981-82	0	0	12	189	423	739	907	636	495	303	21	0	3725
1982-83	0	4	6	177	334	498	762	674	426	295	85	3	3264
1983-84	0	0	27	126	370	718	908	522	601	281	54	3	3610
1984-85	0	0	16	37	450	432	928	686	421	172	21	0	3163
1985-86	0	0	6	61	162	731	790	637	465	228	69	1	3150
1986-87	0	1	8	88	311	620	779	730	538	306	58	0	3439
1987-88	0	0	0	252	320	582	851	646	474	266	86	15	3492
1988-89	0	0	2	265	324	692	602	607	486	282	80	0	3334
1989-90	0	0	12	134	356	928	541	417	410	234	39	3	3074
1990-91	0	0	13	102	301	444	657	527	386	166	19	2	2611
1991-92	0	0	22	132	377	542	686	575	496	262	125	1	3211
1992-93	0	0	9	179	337	623							

See Reference Notes on Page 6B.

COOLING DEGREE DAYS Base 65 deg. F NORFOLK, VIRGINIA

YEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTA
1969	0	0	0	42	125	369	446	357	199	49	0	0	158
1970	1	0	0	19	140	303	374	412	311	60	0	0	162
1971	0	3	0	3	76	336	383	343	259	87	23	5	151
1972	0	0	8	20	40	183	398	343	217	22	10	2	124
1973	0	0	16	27	112	363	420	424	307	64	17	1	175
1974	3	0	16	64	124	244	419	390	213	26	32	0	153
1975	2	3	0	22	157	366	429	460	233	55	17	0	174
1976	1	13	11	102	110	337	417	347	193	27	0	0	155
1977	0	4	16	66	145	289	515	502	347	24	22	0	193
1978	0	0	0	9	96	286	352	487	257	36	3	9	153
1979	0	0	11	13	112	171	385	425	239	54	22	0	143
1980	0	0	0	11	153	274	499	497	351	45	1	1	183
1981	0	0	0	51	103	407	468	320	189	29	0	0	156
1982	0	0	1	8	166	257	428	337	164	39	21	4	141
1983	0	0	0	21	115	250	481	440	265	62	4	0	163
1984	0	0	0	5	146	345	368	426	188	102	5	2	158
1985	0	5	20	91	146	284	419	382	267	97	28	0	173
1986	0	0	2	2	153	343	537	367	237	109	15	0	176
1987	0	0	0	2	168	364	544	467	285	0	7	0	183
1988	0	0	1	18	118	280	477	498	173	17	10	0	159
1989	0	9	30	31	106	412	447	399	286	69	10	0	179
1990	0	8	52	51	98	324	489	407	218	137	8	5	179
1991	0	0	13	71	269	347	534	456	248	43	18	11	201
1992	0	0	0	63	51	220	527	336	270	23	9	0	149

See Reference Notes on Page 6B.

SNOWFALL (inches)

NORFOLK, VIRGINIA

SEASON	JULY	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	TOTAL
1963-64	0.0	0.0	0.0	0.0	0.0	T	T	5.8	T	1.2	0.0	0.0	8.0
1964-65	0.0	0.0	0.0	0.0	T	0.0	10.6	3.9	T	0.0	0.0	0.0	14.5
1965-66	0.0	0.0	0.0	0.0	0.0	T	14.2	0.5	0.0	0.0	0.0	0.0	14.7
1966-67	0.0	0.0	0.0	0.0	T	1.0	4.2	5.1	T	0.0	0.0	0.0	10.3
1967-68	0.0	0.0	0.0	0.0	T	2.0	1.5	2.9	0.9	0.0	0.0	0.0	7.3
1968-69	0.0	0.0	0.0	0.0	T	3.8	T	0.8	T	0.0	0.0	0.0	6.5
1969-70	0.0	0.0	0.0	0.0	0.0	T	3.0	2.8	T	0.0	0.0	0.0	5.8
1970-71	0.0	0.0	0.0	0.0	T	T	T	2.4	4.2	T	0.0	0.0	6.6
1971-72	0.0	0.0	0.0	0.0	T	T	0.0	1.8	T	T	0.0	0.0	1.8
1972-73	0.0	0.0	0.0	0.0	T	0.0	9.1	4.7	T	0.0	0.0	0.0	13.8
1973-74	0.0	0.0	0.0	0.0	0.0	1.4	T	0.9	7.5	0.0	0.0	0.0	9.8
1974-75	0.0	0.0	0.0	0.0	0.0	T	0.3	T	0.8	T	0.0	0.0	1.1
1975-76	0.0	0.0	0.0	0.0	0.0	T	T	T	0.0	0.0	0.0	0.0	T
1976-77	0.0	0.0	0.0	0.0	T	1.0	4.7	1.4	0.0	0.0	0.0	0.0	7.1
1977-78	0.0	0.0	0.0	0.0	0.0	T	1.3	9.2	2.3	0.0	0.0	0.0	12.8
1978-79	0.0	0.0	0.0	0.0	0.0	0.0	1.0	12.7	T	0.0	0.0	0.0	13.7
1979-80	0.0	0.0	0.0	0.0	0.0	0.0	9.3	18.9	13.7	0.0	0.0	0.0	41.9
1980-81	0.0	0.0	0.0	0.0	0.0	T	T	0.0	0.3	0.0	0.0	0.0	0.3
1981-82	0.0	0.0	0.0	0.0	0.0	1.8	4.2	0.1	T	T	0.0	0.0	6.1
1982-83	0.0	0.0	0.0	0.0	0.0	0.4	T	3.0	T	T	0.0	0.0	3.4
1983-84	0.0	0.0	0.0	0.0	0.0	T	T	5.2	T	0.0	0.0	0.0	5.2
1984-85	0.0	0.0	0.0	0.0	0.0	T	4.3	0.0	T	0.0	0.0	0.0	4.3
1985-86	0.0	0.0	0.0	0.0	0.0	T	3.6	1.1	T	T	0.0	0.0	4.7
1986-87	0.0	0.0	0.0	0.0	0.0	T	1.6	1.0	1.2	T	0.0	0.0	3.8
1987-88	0.0	0.0	0.0	0.0	0.3	T	4.4	T	T	0.0	0.0	0.0	4.7
1988-89	0.0	0.0	0.0	0.0	0.0	T	T	24.4	T	0.5	0.0	0.0	24.9
1989-90	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	T	0.0	0.0	T	0.5
1990-91	0.0	0.0	0.0	0.0	0.0	T	0.0	T	T	0.0	0.0	0.0	T
1991-92	0.0	T	0.0	0.0	0.0	T	T	0.0	T	T	0.0	0.0	T
1992-93	0.0	0.0	0.0	0.0	0.0	0.0							
Record Mean	0.0	T	0.0	0.0	T	0.9	2.7	2.9	1.0	T	0.0	T	7.5

See Reference Notes on Page 6B.

REFERENCE NOTES

NORFOLK, VIRGINIA

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

SPECIFIC
PAGE 2
PM - INCLUDES LAST DAY OF PREVIOUS MONTH
ASOS - AUTOMATED SURFACE OBSERVING SYSTEM IN OPERATION DURING THESE MONTHS.

PAGE 3
(a) - LENGTH OF RECORD IN YEARS. ALTHOUGH INDIVIDUAL MONTHS MAY BE MISSING.
0.* OR * - THE VALUE IS BETWEEN 0.0 AND 0.05
NORMALS - BASED ON THE 1951-1980 RECORD PERIOD.
EXTREMES - DATES ARE THE MOST RECENT OCCURRENCE
WIND DIR.- NUMERALS SHOW TENS OF DEGRESS CLOCKWISE FROM TRUE NORTH. 00 INDICATES CALM.
RESULTANT DIRECTIONS ARE GIVEN TO WHOLE DEGREES.
BOLD VALUES INDICATE EXTREME VALUES WHICH OCCURRED AFTER THE ASOS SYSTEM WAS COMMISSIONED.

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

EXCEPTIONS

PAGE 3
1. PERCENT OF POSSIBLE SUNSHINE IS THROUGH 1980.
PAGES 4A, 4B, 6A
RECORD MEANS ARE THROUGH THE CURRENT YEAR, BEGINNING IN 1895 FOR TEMPERATURE
1871 FOR PRECIPITATION
1948 FOR SNOWFALL

NORFOLK, VIRGINIA

The city of Norfolk, Virginia, is located near the coast and the southern border of the state. It is almost surrounded by water, with the Chesapeake Bay immediately to the north, Hampton Roads to the west, and the Atlantic Ocean only 18 miles to the east. It is traversed by numerous rivers and waterways and its average elevation above sea level is 13 feet. There are no nearby hilly areas and the land is low and level throughout the city. The climate is generally marine. The geographic location of the city with respect to the principal storm tracks, is especially favorable, being south of the average path of storms originating in the higher latitudes and north of the usual tracks of hurricanes and other tropical storms.

The winters are usually mild, while the autumn and spring seasons usually are delightful. Summers, though warm and long, frequently are tempered by cool periods, often associated with northeasterly winds off the Atlantic. Temperatures of 100 degrees or higher occur infrequently. Extreme cold waves seldom penetrate the area and temperatures of zero or below are almost nonexistent. Winters pass, on occasion, without a measurable amount of snowfall. Most of the snowfall in Norfolk is light and generally melts within 24 hours.

Based on the 1951-1980 period, the average first occurrence of 32 degrees Fahrenheit in the fall is November 17 and the average last occurrence in the spring is March 23.

STATION LOCATION

NORFOLK, VIRGINIA

LOCATION	OCCUPIED FROM	OCCUPIED TO	AIRLINE DISTANCES AND DIRECTIONS FROM PREVIOUS LOCATION	LATITUDE NORTH	LONGITUDE WEST	ELEVATION ABOVE SEA LEVEL: GROUND TEMPERATURE	ELEVATION ABOVE GROUND: SITE	WIND INSTRUMENTS	EXTREME THERMOMETERS	PSYCHROMETER	SUNSHINE SWITCH	TIPPING BUCKET	RAIN GAGE	WEIGHING RAIN GAGE	8 INCH RAIN GAGE	HYGROTHERMOMETER	AUTOMATIC OBSERVING	EQUIPMENT *	REMARKS
CITY - - NOTE: For period January 1, 1871 through January 31, 1888, refer to previous editions.																			
Dodson Building (5th Floor) 53-55 Main Street	2/01/88	1/23/90	500 ft. W	36° 51'	76° 18'		10	85	82	82					80				
Dodson Building (2nd Floor) 53-55 Main Street	1/24/90	5/18/92	Same Bldg.	36° 51'	76° 18'		10	93	82	82					80				
Dodson Building (3rd Floor) 53-55 Main Street	5/19/92	12/31/98	Same Bldg.	36° 51'	76° 18'		10	93	82	82		80			80				Tipping bucket gage installed about 1897.
Citizens Bank Building 191-195 Main Street	1/01/99	12/31/12	200 ft. E	36° 51'	76° 18'		10	111	98	98		96			96				
Royster Building 201-203 Granby Street	1/01/13	2/22/17	500 ft. N	36° 51'	76° 18'		9	205	170	170		163			163				
Royster Building 201-203 Granby Street	2/23/17	11/30/34	Same Bldg.	36° 51'	76° 18'		9	205	170	170		178			178				One story added to part of building. Rain gages relocated.
U.S. Post Office and Fed. Court Building 600 Granby Street	12/01/34	7/31/53	1000 ft. N	36° 51'	76° 17'		11	125	80	80		73			73				WBO Norfolk was combined with WBAS at the Norfolk Municipal Airport on 8/1/53.
COOPERATIVE Virginia Electric Gas Plant, Starr and Monticello Streets	8/01/53	1965	0.3 mi. N	36° 52'	76° 17'		11		5						3				
AIRPORT Norfolk Municipal AP 5.4 Airline Miles ENE of Post Office	7/08/38	5/01/40	NA	36° 53'	76° 12'		25	25		5									
Norfolk Municipal AP	5/01/40	3/05/52	900 ft. WNW	36° 53'	76° 12'		25	55	6	6		3			3				
Norfolk Municipal AP+	3/05/52	Present	0.25 mi. N	36° 54'	76° 12'		c24	a34 b78 e90 h33	6	6	%64	3	NA		3	#4 f4 g4	NA		

+ Norfolk Regional Airport effective 11/1/68. International Airport in Nov. 1976.

* Type
M = AMOS
T = AUTOB
S = ASOS
W = AMOS

\# - Telepsychrometer (4') 3/5/52 to 8/31/59. Hygro comm. 470' SE of office 8/31/59.
a - Direct reading sensor on field.
b - Autographic record sensor.
c - 26 ft. to 8/31/59 and 22 ft. to 12/8/59.
d - Data source to 8/31/59.
e - Relocated 8/24/73.
f - Moved 1210 ft. SE on 5/18/78.
% - Commissioned 8/2/53.
g - Type change 1/22/80.
h - Moved 80 ft. NW 3/5/82.

SUBSCRIPTION:
Price and ordering information available through: National Climatic Data Center, Federal Building, Asheville, North Carolina 28801.
INQUIRIES/COMMENTS CALL: (704) 271-4800 USCOMM-NOAA-ASHEVILLE, N.C. - 655

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Federal Building
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United States Department of Commerce
NOAA Permit No. G - 19

13737

NNNN

Preliminary Local Climatological Data (WS Form: F-6)

Station: WSO. NORFOLK. VA
Month: MAY
Year: 1993

Latitude +3654 Longitude +7612 Gnd Elev. 24 ft. Std Time: EST

Temperature in Fahrenheit							: Precip(in.):		Snow	: Wind	: Fastest 1-Min:			Sunshine :	Sky		: Peak Win
Columns																	
-1- Day	-2- Max	-3- Min	-4- Avg	-5- Dep.	-6a- HDD	-6b- CDD	-7- Water	-8- Snow	-9- Depth	-10- Avg.	-11- Speed	-12- Dir	-13- Mins.	-14- PSBL	-15- SR-SS	-16- Weather	-17- Speed	-1 Di
1	78	46	62	0	3	0	0.00	0.0	0	6.6	14	13	792	96	6		20	S
2	81	54	68	6	0	3	0.00	0.0	0	9.7	16	14	687	83	4		22	S
3	74	57	66	4	0	1	0.00	0.0	0	9.0	15	09	640	77	8	1	21	
4	77	61	69	6	0	4	T	0.0	0	11.0	20	12	317	38	8		23	
5	74	64	69	6	0	4	0.21	0.0	0	9.2	12	15	82	10	10		18	S
6	79	61	70	7	0	5	0.17	0.0	0	7.9	21	26	663	80	3	1.3.8	29	
7	74	58	66	3	0	1	0.00	0.0	0	8.4	16	05	631	76	3	1.8	20	N
8	73	55	64	0	1	0	0.00	0.0	0	8.1	12	13	763	91	3		17	
9	81	53	67	3	0	2	0.00	0.0	0	7.5	15	14	720	86	6		18	S
10	84	59	72	8	0	7	0.00	0.0	0	9.4	17	12	699	83	1		20	S
11	87	62	75	10	0	10	0.00	0.0	0	10.5	14	24	704	84	1	8	21	S
12	89	64	77	12	0	12	0.23	0.0	0	9.7	20	33	478	57	8	1.3.8	30	N
13	82	62	72	7	0	7	0.20	0.0	0	12.8	17	05	241	29	10		29	S
14	67	55	61	-4	4	0	0.20	0.0	0	9.0	16	05	415	49	8	1	21	N
15	82	53	68	2	0	3	0.00	0.0	0	11.7	21	22	848	100	0		28	S
16	87	63	75	9	0	10	0.00	0.0	0	13.4	20	24	839	99	2		37	
17	74	62	68	1	0	3	0.00	0.0	0	9.1	20	05	379	45	9	1.8	20	N
18	84	62	73	6	0	0	0.06	0.0	0	9.2	10	33	213	25	9	2.3.8	33	N
19	79	63	71	4	0	6	0.57	0.0	0	7.9	14	16	224	26	9	1.3	21	
20	66	58	62	-5	3	0	0.02	0.0	0	10.1	16	36	0	0	9	1.8	22	
21	67	51	59	-9	6	0	0.00	0.0	0	8.7	16	01	699	82	3		21	N
22	69	52	61	-7	4	0	0.05	0.0	0	7.1	15	01	478	56	4	3	24	
23	79	50	65	-3	0	0	0.00	0.0	0	7.9	16	22	737	86	6		16	S
24	83	62	73	5	0	8	0.00	0.0	0	15.0	20	21	735	85	5		28	S
25	87	67	77	8	0	12	0.00	0.0	0	13.9	18	23	715	83	7		28	
26	71	58	65	-4	0	0	0.48	0.0	0	7.3	16	01	125	14	9	1	23	
27	83	56	70	1	0	5	0.00	0.0	0	6.6	10	28	689	80	4	1	16	N
28	86	61	74	4	0	9	0.00	0.0	0	14.2	20	22	842	97	3		28	S
29	88	64	76	6	0	11	0.22	0.0	0	11.9	16	03	493	57	9	3	25	N
30	70	58	64	-6	1	0	0.00	0.0	0	10.2	18	06	853	98	0		25	N
31	82	57	70	0	0	5	0.47	0.0	0	12.1	10	23	182	21	9	1.3	33	S
Sum	2437	1808			22	136	2.88	0.0		305.9			16883		176			
Avg	78.6	58.3								9.9	Fast	Dir.	Psbl	%	5.7		Max (mo
									Misc ------>		210	22	26303	64			037 N

Notes:

0 Last of several occurrences

Column 9 readings are taken at 0700

Column 17 Peak Wind in M.P.H.

Preliminary Local Climatological Data (WS Form: F-6). Page 2

Station: WSO. NORFOLK. VA
Month: MAY
Year: 1993

[Temperature Data]

Average Monthly: 68.5
Departure from Normal: +2.4
Highest: 89 on 12
Lowest: 46 on 1

[Precipitation Data]

Total for Month: 2.88
Departure from Normal: -0.93
Greatest in 24 hrs. 0.62 on 18-19

SNOWFALL. ICE PELLETS. HAIL
Total for month: 0.0 inches
Greatest snowfall in 24 hrs: 0.0 on
Greatest snow depth: on

SYMBOLS USED IN COLUMN 16

1 = FOG
2 = FOG REDUCING VISIBILITY TO 1/4 MILE OR LESS
3 = THUNDER
4 = ICE PELLETS
5 = HAIL
6 = GLAZE OR RIME
7 = BLOWING DUST OR BLOWING SAND REDUCING VISIBILITY TO 1/2 MILE OR LESS
8 = SMOKE OR HAZE
9 = BLOWING SNOW
X = TORNADO

[No. of Days with]

Max 32 or below: 0
Max 90 or above: 0
Min 32 or below: 0
Min 0 or below: 0

[WEATHER - No. of Days with]

0.01 inch or more Precip: 12
0.10 inch or more Precip: 9
0.50 inch or more Precip: 1
1.00 inch or more Precip: 0

[Heating Degree Days (Base 65)]

Total this Month: 22
Departure from Normal: -31
Seasonal Total: 3331
Departure from Normal: -115

Clear (scale 0-3) 10
Partly Cloudy (scale 4-7) 8
Cloudy (scale 8-10) 13

[Cooling Degree Days (Base 65)]

Total this Month: 136
Departure from Normal: +51
Seasonal Total: 159
Departure from Normal: +65

[Pressure Data]

Highest Sea-Level 30.34 in. on 3
Lowest Sea-Level 29.58 in. on 13

Maximum Precipitation

(Delta T) (Minutes)	5	10	15	20	30	45	60	80	100	120	150	180
Precipitation (Inches)	0.13	0.19	0.21	0.22	0.26	0.28	0.28	0.28	0.30	0.33	0.34	0.43
Ended Date	31	31	31	31	31	31	31	31	27	27	27	27
Time	1553	1556	1600	1606	1616	1631	1646	1706	848	848	928	958

13737

KEYED BY 04949

Preliminary Local Climatological Data (WS Form: F-6)

Station: WSO, NORFOLK, VA
Month: JUN
Year: 1993

Latitude +3654 Longitude +7612 Gnd Elev. 24 ft. Std Time: EST

Temperature in Fahrenheit							: Precip(in.):		Snow :	Wind :	Fastest 1-Min:			Sunshine :	Sky		: Peak Wind
Columns																	
-1- Day	-2- Max	-3- Min	-4- Avg	-5- Dep.	-6a- HDD	-6b- CDD	-7- Water	-8- Snow	-9- Depth	-10- Avg.	-11- Speed	-12- Dir	-13- Mins.	-14- %PSBL	-15- SR-SS	-16- Weather	-17- Speed
1	71	54	63	-8	2	0	0.46	0.0	0	11.3	23	01	378	43	6	1	39
2	73	51	62	-9	3	0	0.00	0.0	0	9.2	17	08	757	87	4	1	22
3	77	62	70	-1	0	5	0.93	0.0	0	8.5	17	30	174	20	9	3,8	31
4	80	63	72	0	0	7	0.07	0.0	0	8.7	16	34	539	62	5	1,3,8	33
5	89	63	76	4	0	11	0.22	0.0	0	9.5	20	36	600	69	5	1,3,8	28
6	76	59	68	-4	0	3	0.00	0.0	0	12.9	20	36	733	84	4		33
7	84	57	71	-1	0	6	0.00	0.0	0	10.1	15	24	802	92	7		25
8	91	70	81	8	0	16	0.00	0.0	0	11.0	18	23	392	45	9	1,3,8	23
9	96	77	87	14	0	22	0.00	0.0	0	11.8	16	24	717	82	6	8	26
10	97	78	88	15	0	23	0.00	0.0	0	10.1	15	28	806	92	1	8	21
11	86	73	80	7	0	15	T	0.0	0	8.9	16	28	660	75	7	3,8	30
12	75	68	72	-1	0	7	0.00	0.0	0	11.5	17	06	305	35	9		23
13	73	66	70	-4	0	5	0.00	0.0	0	13.0	20	05	95	11	10		25
14	77	66	72	-2	0	7	0.00	0.0	0	12.3	18	07	321	36	7		26
15	85	65	75	1	0	10	0.00	0.0	0	9.7	15	19	459	52	7		25
16	84	71	78	4	0	13	0.00	0.0	0	8.1	13	04	633	72	8		18
17	87	70	79	4	0	14	0.00	0.0	0	7.6	14	04	864	98	6		15
18	94	70	82	7	0	17	0.00	0.0	0	11.0	14	21	617	70	6		21
19	96	74	85	10	0	20	0.00	0.0	0	11.5	15	22	621	70	1	8	21
20	96	75	86	11	0	21	0.00	0.0	0	11.3	16	23	672	76	1	8	23
21	90	72	81	6	0	16	T	0.0	0	11.9	17	22	320	36	9		22
22	90	73	82	6	0	17	T	0.0	0	11.4	17	28	666	76	6		23
23	80	62	71	-5	0	6	0.00	0.0	0	10.0	17	36	862	98	0	8	23
24	86	58	72	-4	0	7	0.00	0.0	0	7.7	13	04	865	98	0		16
25	86	60	73	-3	0	8	0.00	0.0	0	8.1	15	14	854	97	1		23
26	89	69	79	3	0	14	T	0.0	0	9.4	16	20	548	62	6		21
27	82	69	76	0	0	11	0.10	0.0	0	7.6	15	01	469	53	7	1	17
28	91	66	79	2	0	14	0.00	0.0	0	6.8	14	06	678	77	7	2,8	20
29	95	71	83	6	0	18	0.13	0.0	0	9.5	17	20	605	69	6	1,8	23
30	86	68	77	0	0	12	0.00	0.0	0	6.3	12	34	526	60	8	1,8	16
Sum	2562	2000			5	345	2.79	0.0		297.5			17538		168		
Avg	85.4	66.7								9.9	Fast	Dir.	Psbl	%	5.6		Max (mph
									Misc -------->		23	01	26357	67			039 N

Notes:
Column 9 readings are taken at 0700
Column 17 Peak Wind in M.P.H.

Preliminary Local Climatological Data (WS Form: F-6), Page 2

Station: WSO, NORFOLK, VA
Month: JUN
Year: 1993

[Temperature Data]

Average Monthly: 76.1
Departure from Normal: +2.0
Highest: 97 on 10
Lowest: 51 on 2

[Precipitation Data]

Total for Month: 2.79
Departure from Normal: -1.03
Greatest in 24 hrs. 1.76 on 3-4

SNOWFALL, ICE PELLETS, HAIL
Total for month: 0.0 inches
Greatest snowfall in 24 hrs: on
Greatest snow depth: on

SYMBOLS USED IN COLUMN 16

1 = FOG
2 = FOG REDUCING VISIBILITY TO 1/4 MILE OR LESS
3 = THUNDER
4 = ICE PELLETS
5 = HAIL
6 = GLAZE OR RIME
7 = BLOWING DUST OR BLOWING SAND REDUCI VISIBILITY TO 1/2 MILE OR LESS
8 = SMOKE OR HAZE
9 = BLOWING SNOW
X = TORNADO

[No. of Days with]

Max 32 or below: 0
Max 90 or above: 10
Min 32 or below: 0
Min 0 or below: 0

[WEATHER - No. of Days with]

0.01 inch or more Precip: 7
0.10 inch or more Precip: 6
0.50 inch or more Precip: 2
1.00 inch or more Precip: 0

[Heating Degree Days (Base 65)]

Total this Month: - 5
Departure from Normal: +5
Seasonal Total: 3336
Departure from Normal: -110

Clear (scale 0-3) 6
Partly Cloudy (scale 4-7) 17
Cloudy (scale 8-10) 7

[Cooling Degree Days (Base 65)]

Total this Month: 345
Departure from Normal: +60
Seasonal Total: 504
Departure from Normal: +133

[Pressure Data]

Highest Sea-Level 30.31 in. on 25
Lowest Sea-Level 29.75 in. on 4

KEYED BY 04040

Maximum Precipitation

(Delta T) (Minutes)	5	10	15	20	30	45	60	80	100	120	150	180
Precipitation (Inches)	0.23	0.40	0.56	0.75	0.88	0.89	0.91	1.12	1.12	1.14	1.24	1.25
Ended Date	3	3	3	3	3	4	4	4	4	4	4	4
Time	2335	2340	2345	2350	2356	7	22	42	102	122	152	222

1373

KEYED BY 04848

Preliminary Local Climatological Data (WS Form: F-6)

Station: WSO, NORFOLK, VA
Month: JUL
Year: 1993

Latitude +3654 | Longitude +7612 | Gnd Elev. 24 ft. | Std Time: EST

Temperature in Fahrenheit							: Precip(in.):		Snow :	Wind :	Fastest 1-Min:		Sunshine :		Sky		: Peak W
Columns																	
-1- Day	-2- Max	-3- Min	-4- Avg	-5- Dep.	-6a- HDD	-6b- CDD	-7- Water	-8- Snow	-9- Depth	-10- Avg.	-11- Speed	-12- Dir	-13- Mins.	-14- ZPSBL	-15- SR-SS	-16- Weather	-17- Speed
1	84	70	77	0	0	12	0.00	0.0	0	9.5	20	05	489	56	5	1,8	24
2	88	74	81	4	0	16	T	0.0	0	7.1	13	19	270	31	10	8	25
3	95	74	85	8	0	20	0.27	0.0	0	9.4	14	27	484	46	7	1,3,8	29
4	89	74	82	5	0	17	0.02	0.0	0	6.6	10	26	580	66	8	8	18
5	94	75	85	8	0	20	0.00	0.0	0	5.7	09	04	733	84	1	1,8	14
6	95	75	85	7	0	20	0.00	0.0	0	7.1	12	17	471	54	3	1,8	17
7	96	77	87	9	0	22	T	0.0	0	8.3	13	22	453	52	4	3,8	29
8	100	78	89	11	0	24	0.00	0.0	0	8.9	14	20	704	81	3	8	22
9	98	79	89	11	0	24	0.00	0.0	0	7.3	10	34	700	81	1	8	17
10	99	77	88	10	0	23	0.04	0.0	0	8.9	30	31	649	74	2	3,8	47
11	97	77	87	9	0	22	0.00	0.0	0	7.8	10	20	795	91	1	8	16
12	98	79	89	11	0	24	0.00	0.0	0	8.2	14	20	719	83	3		18
13	95	79	87	9	0	22	0.00	0.0	0	7.2	14	04	537	62	5	3,8	25
14	101	75	88	10	0	23	0.00	0.0	0	8.5	14	23	676	78	4	8	23
15	92	79	86	8	0	21	T	0.0	0	8.6	14	36	298	34	9	8	23
16	87	73	80	2	0	15	0.00	0.0	0	9.1	16	05	732	85	5	8	23
17	85	69	77	-1	0	12	0.00	0.0	0	8.3	17	04	791	92	4		23
18	90	67	79	1	0	14	0.00	0.0	0	7.3	14	12	765	89	4		18
19	90	77	84	3	0	19	0.01	0.0	0	11.5	17	19	155	18	9		28
20	91	78	85	6	0	20	0.00	0.0	0	9.5	14	01	500	58	4	1,8	21
21	89	77	83	4	0	18	0.00	0.0	0	8.8	14	04	737	86	4	8	24
22	85	68	77	-2	0	12	0.00	0.0	0	6.9	15	04	502	59	7	1,8	21
23	86	66	76	-3	0	11	0.00	0.0	0	6.0	12	06	361	42	9		16
24	90	74	82	3	0	17	T	0.0	0	7.8	20	18	247	29	8	1,3,8	29
25	87	76	82	3	0	17	0.02	0.0	0	6.1	14	07	188	22	8	1,8	17
26	88	75	82	3	0	17	0.00	0.0	0	8.8	14	13	392	46	7		22
27	89	76	83	4	0	18	0.00	0.0	0	10.4	18	24	295	35	8		25
28	94	76	85	6	0	20	0.00	0.0	0	8.6	12	36	767	90	2	8	20
29	103	79	91	12	0	26	0.00	0.0	0	10.2	16	28	644	76	5	8	25
30	93	74	84	6	0	19	0.00	0.0	0	8.5	17	36	482	57	3		26
31	85	73	79	1	0	14	0.00	0.0	0	9.8	16	36	488	58	5		25
Sum	2853	2320			0	579	0.36	0.0		256.7			16532		158		
Avg	92.0	74.8								8.3	Fast	Dir.	Psbl	%	5.1		Max
									Misc -------->		30	31	26792	62			247

Notes:
Column 9 readings are taken at 0700
Column 17 Peak Wind in M.P.H.

Preliminary Local Climatological Data (WS Form: F-6), Page 2

Station: WSO, NORFOLK, VA
Month: JUL
Year: 1993

[Temperature Data]

Average Monthly: 83.4
Departure from Normal: +5.2
Highest: 103 on 29
Lowest: 66 on 23

[Precipitation Data]

Total for Month: 0.36
Departure from Normal: -4.70
Greatest in 24 hrs. 0.29 on 3-4

SNOWFALL, ICE PELLETS, HAIL
Total for month: 0.0 inches
Greatest snowfall in 24 hrs: on
Greatest snow depth: on

SYMBOLS USED IN COLUMN 16

1 = FOG
2 = FOG REDUCING VISIBILITY TO 1/4 MILE OR LESS
3 = THUNDER
4 = ICE PELLETS
5 = HAIL
6 = GLAZE OR RIME
7 = BLOWING DUST OR BLOWING SAND REDUC VISIBILITY TO 1/2 MILE OR LESS
8 = SMOKE OR HAZE
9 = BLOWING SNOW
X = TORNADO

[No. of Days with]

Max 32 or below: 0
Max 90 or above: 19
Min 32 or below: 0
Min 0 or below: 0

[WEATHER - No. of Days with]

0.01 inch or more Precip: 5
0.10 inch or more Precip: 1
0.50 inch or more Precip: 0
1.00 inch or more Precip: 0

[Heating Degree Days (Base 65)]

Total this Month: 0
Departure from Normal: 0
Seasonal Total: 0
Departure from Normal: 0

[Cooling Degree Days (Base 65)]

Total this Month: 579
Departure from Normal: +170
Seasonal Total: 1083
Departure from Normal: +303

Clear (scale 0-3) 9
Partly Cloudy (scale 4-7) 14
Cloudy (scale 8-10) 8

[Pressure Data]

Highest Sea-Level 30.13 in. on 18
Lowest Sea-Level 29.75 in. on 29

Maximum Precipitation

(Delta T) (Minutes)	5	10	15	20	30	45	60	80	100	120	150	180
Precipitation (Inches)	0.03	0.04	0.05	0.06	0.08	0.12	0.14	0.18	0.21	0.24	0.26	0.27
Ended Date	3	3	3	3	3	3	3	3	3	3	4	4
Time	2203	2204	2209	2214	2224	2239	2253	2313	2333	2353	9	39

KEYED BY 04940

DRIEST JULY ON RECORD. SECOND WARMEST JULY ON RECORD.

APPENDIX G

Chain-of-Custody Forms

CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #:

Project name: NAB - Little Creek

Samplers (Please print): M. Schmidt / P. Scian

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	TC Inorganics	TPH	TOC	Remarks
5/12/93	1056		✓	09-SS-101	4oz	1	✓	✓	✓	
	1056		✓	09-SS-101	8oz	1	✓	✓	✓	
	1100	1103	✓	09-SS-102	4oz	1	✓	✓	✓	
	1100	1103	✓	09-SS-102	8oz	1	✓	✓	✓	
	1103	1106	✓	09-SS-103	4oz	1	✓	✓	✓	
	1103	1106	✓	09-SS-103	8oz	1	✓	✓	✓	
	1106	1108	✓	09-SS-104	4oz	1	✓	✓	✓	
	1106	1108	✓	09-SS-104	8oz	1	✓	✓	✓	
	1108	1115	✓	09-SS-105	4oz	1	✓	✓	✓	
	1108	1115	✓	09-SS-105	8oz	1	✓	✓	✓	
	1108	1119	✓	09-SS-106	4oz	1	✓	✓	✓	
	1108	1119	✓	09-SS-106	8oz	1	✓	✓	✓	
	1115	1100	✓	09-SS-107	4oz	1	✓	✓	✓	
↓	1115	1100	✓	09-SS-107	8oz	1	✓	✓	✓	

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Michael J. Schmidt	5/12/93 1800		
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time

Remarks: 1 of 4

CEIMIC Corporation 10 Dean Knauss Drive, Narragansett, RI 02882 (401) 782-8900 FAX (401) 782-8905

CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #:

Project name: NAB - Little Creek

Samplers (Please print): M. Schmidt

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	TCL organics	TPH	TOC	Remarks
5/12/93	1404		✓	10-SS-101	4oz.	1	✓	✓	✓	
	1404		✓	10-SS-101	8oz	1	✓	✓	✓	
	1412		✓	10-SS-102	4oz.	1	✓	✓	✓	
	1412		✓	10-SS-102	8oz.	1	✓	✓	✓	
	1427		✓	10-SS-103	4oz.	1	✓	✓	✓	
	1427		✓	10-SS-103	8oz.	1	✓	✓	✓	
	1435		✓	10-SS-104	4oz.	1	✓	✓	✓	
	1435		✓	10-SS-104	8oz.	1	✓	✓	✓	
	1442		✓	10-SS-105	4oz.	1	✓	✓	✓	
	1442		✓	10-SS-105	8oz.	1	✓	✓	✓	
	1457		✓	10-SS-106	4oz.	1	✓	✓	✓	
	1457		✓	10-SS-106	8oz.	1	✓	✓	✓	
	507		✓	10-SS-107	4oz.	1	✓	✓	✓	
	1507		✓	10-SS-107	8oz.	1	✓	✓	✓	

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Remarks:
M. Schmidt	5/12/93 1800			2 of 4
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	

CEIMIC Corporation 10 Dean Knauss Drive, Narragansett, RI 02882 (401) 782-8900 FAX (401) 782-8905

CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #:

Project name: NAB - Little Creek

Samplers (Please print): M. Schmidt / A. Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	TCL organics	TPH	TOC	TOX								Remarks
5/12/93	1507		✓	10-SS-107-MS/MSD	4oz.	1	✓	✓	✓									
	1507		✓	10-SS-107-MS/MSD	8oz.	1	✓	✓	✓									
	1516		✓	10-SS-108	4oz.	1	✓	✓	✓									
	1516		✓	10-SS-108	8oz.	1	✓	✓	✓									
	1500		✓	10-SS-109	4oz.	1	✓	✓	✓									
	1500		✓	10-SS-109	8oz.	1	✓	✓	✓									
	1615		✓	10-FB-101	1l	2	✓											
	1615		✓	10-FB-101	1l	1		✓										
	1615		✓	10-FB-101	250ml	1			✓									H_2SO_4
	1630		✓	10-SS-108-ER	1l	2	✓											
	1630		✓	10-SS-108-ER	1l	1		✓										
	1630		✓	10-SS-108-ER	250ml	1			✓									H_2SO_4
	1615		✓	10-FB-101	40ml	2	✓											HCl
	1630		✓	10-SS-108-ER	40ml	2	✓											HCl

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Remarks:
Michael J. Schmidt	5/12/93 1800			3 of 4
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #

Project name: NAB-Little Creek

Samplers (Please print): N. Garibaldi, M. Schmidt

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	VOA										Remarks
5/12/93			✓	Trip Blank-1	40ml	2	✓										HCl
5/12/93			✓	Trip Blank-2	40ml	2	✓										HCl

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Remarks:
Michael J. Schmidt	5/12/93 1800			4 of 4
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #:

Project name: NAB - Little Creek

Samplers (Please print): Michael Schmidt / Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	TAL Metals Total	+ Cyanide Total	TAL Inorganics	Remarks
5/13/93	0805		✓	09-SS-101	8oz	1	✓			
	0810		✓	09-SS-102	8oz	1	✓			
	0815		✓	09-SS-103	8oz	1	✓			
	0820		✓	09-SS-104	8oz	1	✓			
	0825		✓	09-SS-105	8oz	1	✓			
	0828		✓	09-SS-106	8oz	1	✓			
	0830		✓	09-SS-107	8oz	1	✓			
	0845		✓	10-SS-101	8oz	1		✓		
	0848		✓	10-SS-102	8oz	1		✓		
	0855		✓	10-SS-103	8oz	1		✓		
	0858		✓	10-SS-104	8oz	1		✓		
	0900		✓	10-SS-105	8oz	1		✓		
	0903		✓	10-SS-106	8oz	1		✓		
↓	0906		✓	10-SS-107	8oz	1		✓		

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Michael Schmidt	5/13/93 1500		
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time

Remarks: 1 of 7

CEIMIC Corporation 10 Dean Knauss Drive, Narragansett, RI 02882 (401) 782-8900 FAX (401) 782-8905

CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #:

Project name: NAB - Little Creek

Samplers (Please print): Michael Schmidt/Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	Total TAL	Inorganics	TCL VOCs	TOC	TCL SVOCs								Remarks
5/13/93	0906		✓	10-SS-107-MS/MSD	8oz	1	✓												
	0909		✓	10-SS-108	8oz	1	✓												
	0851		✓	10-SS-109	8oz	1	✓												
	0952		✓	13-SS-101	4oz	1			✓	✓									
	0952		✓	13-SS-102	8oz	1					✓								
	0958		✓	13-SS-102	4oz	1			✓	✓									
	0958		✓	13-SS-102	8oz	1					✓								
	1004		✓	13-SS-103	4oz	1			✓	✓									
	1004		✓	13-SS-103	8oz	1					✓								
	1020		✓	13-SS-104	4oz	1			✓	✓									
	1020		✓	13-SS-104	8oz	1					✓								
	1025		✓	13-SS-105	4oz	1			✓	✓									
	1025		✓	13-SS-105	8oz	1					✓								
↓	1030		✓	13-SS-106	4oz	1			✓	✓									

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Remarks:
Michael Schmidt	5/13/93 1800			2 of 7
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. # | Project name: NAB - Little Creek

Samplers (Please print): Michael Schmidt / Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	TCL SVOCs	Full TCL (total metals)	TPH	TOC								Remarks
5/13/93	1030		✓	13-SS-106	8oz	1	✓											
	1201		✓	07-SS-101	4oz	1		✓										
	1201		✓	07-SS-101	8oz	1			✓									
	1201		✓	07-SS-101	8oz	1				✓								
	1218		✓	07-SS-102	4oz	1		✓										
	1218		✓	07-SS-102	8oz	1			✓									
	1218		✓	07-SS-102	8oz	1				✓								
	1238		✓	07-SS-103	4oz	1		✓										
	1238		✓	07-SS-103	8oz	1			✓									
	1238		✓	07-SS-103	8oz	1				✓								
	1250		✓	07-SS-104	4oz	1		✓										
	1250		✓	07-SS-104	8oz	1			✓									
	1250		✓	07-SS-104	8oz	1				✓								
	1250		✓	07-SS-104-MS/MSD	4oz	1		✓										

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Remarks:
Michael Schmidt	5/13/93 1500			3 of 7
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #: Project name: NNR - Little Creek

Samplers (Please print): Michael Schmidt / Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	~~PCB~~	~~Full TCL~~	~~Full TCL TPH~~	TOC										Remarks
5/13/93	1250		✓	07-SS-104-MS/MSD	8oz	1			✓											
	1250		✓	07-SS-104-MS/MSD	8oz	1				✓										
	1307		✓	07-SS-105	4oz	1		✓												
	1307		✓	07-SS-105	8oz	1			✓											
	1307		✓	07-SS-105	8oz	1				✓										
	1319		✓	07-SS-106	4oz	1		✓												
	1319		✓	07-SS-106	8oz	1			✓											
	1319		✓	07-SS-106	8oz	1				✓										
	1329		✓	07-SS-107	4oz	1		✓												
	1329		✓	07-SS-107	8oz	1			✓											
	1329		✓	07-SS-107	8oz	1				✓										
	1346		✓	07-SS-108	4oz	1		✓												
	1346		✓	07-SS-108	8oz	1			✓											
↓	1346		✓	07-SS-108	8oz	1				✓										

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Remarks:
Michael J. Schmidt	5/13/93 1800			4 of 7
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. # | Project name: NAB - Little Creek

Samplers (Please print): Michael Schmidt / Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	Full TCL (+ metals)	TPH	TOC	TCL VOCs								Remarks
5/13/93	1330		✓	07-SS-109	4oz	1	✓											
	1330		✓	07-SS-109	8oz	1		✓										
	1330		✓	07-SS-109	8oz	1			✓									
	1442		✓	11-SS-101	4oz	1			✓	✓								
	1427		✓	11-SS-102	4oz	1			✓	✓								
	1429		✓	11-SS-103	4oz	1			✓	✓								
	1432		✓	11-SS-104	4oz	1			✓	✓								
	1432		✓	11-SS-104D-MS/MSD	4oz	1			✓	✓								
	1437		✓	11-SS-105	4oz	1			✓	✓								
	1440		✓	11-SS-106	4oz	1			✓	✓								
	1445		✓	11-SS-107	4oz	1			✓	✓								
	1447		✓	11-SS-108	4oz	1			✓	✓								
	1450		✓	11-SS-109	4oz	1			✓	✓								
	1451		✓	11-SS-110	4oz	1			✓	✓								

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Remarks:
Michael Schmidt	5/13/93 1800			5 of 7
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. # | Project name: NAB-Little Creek

Samplers (Please print): Michael Schmidt / Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	TCL VOC	TCL Organics	TPH	TOC	TOTAL Inorganics (metals + CN)							Remarks
5/13/93	1503		✓	11-SS-111	4oz	1	✓	✓										
	1515		✓	11-SS-ER	40ml	2			✓									HCl
	1515		✓	11-SS-ER	1lg	2			✓									
	1515		✓	11-SS-ER	1lg	1				✓								
	1515		✓	11-SS-ER	250ml	1					✓							H_2SO_4
	1515		✓	11-SS-ER	1lp	1						✓						NaOH
	1515		✓	11-SS-ER	500ml	1						✓						HNO_3
	1500		✓	11-FB-101	40ml	2			✓									HCl
	1500		✓	11-FB-101	1lg	2			✓									
	1500		✓	11-FB-101	1lg	1				✓								
	1500		✓	11-FB-101	250ml	1					✓							H_2SO_4
	1500		✓	11-FB-101	1lp	1						✓						NaOH
	1500		✓	11-FB-101	500ml	1						✓						HNO_3
✓	—		—	~~Trip~~ Trip Blank-3	40ml	1	✓											HCl

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Michael Schmidt	5/13/93 1800		
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time

Remarks: 6 of 7

CEIMIC Corporation 10 Dean Knauss Drive, Narragansett, RI 02882 (401) 782-8900 FAX (401) 782-8905

CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #

Project name: NAB-Little Creek

Samplers (Please print): Michael Schmidt/Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	Tc VOC											Remarks
5/13/93	–		–	Trip Blank-4	40ml	1	1											HCl

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Remarks:
Michael Schmidt	5/13/93 1800			7 of 7
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #:

Project name: NAB - Little Creek

Samplers (Please print): Michael Schmidt / Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	VOC	Total Lead	Dissolved Lead	Calcium, Magnesium, Hardness, Bicarbonate								Remarks
5/14/93	1153		✓	05GW-101	40ml	2	✓											HCl
	1153		✓	05GW-101	500ml	1		✓										HNO_3
	1153		✓	05GW-101	500ml	1			✓									HNO_3
	1153		✓	05GW-101	1lg	1				✓								
	1208		✓	05GW-102	40ml	2	✓											HCl
	1208		✓	05GW-102	500ml	1		✓										HNO_3
	1208		✓	05GW-102	500ml	1			✓									HNO_3
	1208		✓	05GW-102	1lg	1				✓								
	1232		✓	05GW-103	40ml	2	✓											HCl
	1232		✓	05GW-103	500ml	1		✓										HNO_3
	1232		✓	05GW-103	500ml	1			✓									HNO_3
	1232		✓	05GW-103	1lg	1				✓								
	1248		✓	05GW-104	40ml	2	✓											HCl
✓	1248		✓	05GW-104	500ml	1		✓										HNO_3

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Michael Schmidt	5/14/93		
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time

Remarks: 1 of 3

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #

Project name: NAB - Little Creek

Samplers (Please print): Michael Schmidt / Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	VOC	Total Lead	Dissolved Lead (filtered)	Calcium, Magnesium, Bicarbon.								Remarks
1/14/98	1248		✓	OS-GW-104	1	500ml			✓									HNO_3
	1248		✓	OSGW-104	1	1lg				✓								
	1248		✓	OS-GW-104-MS/MSD	2	40ml	✓											HCl
	1248		✓	OSGW-104-MS/MSD	1	500ml		✓										HNO_3
	1248		✓	OSGW-104-MS/MSD	1	500ml			✓									HNO_3
	1248		✓	OSGW-104-MS/MSD	1	1lg				✓								
	1300		✓	OSGW-105	2	40ml	✓											HCl
	1300		✓	OSGW-105	1	500ml		✓										HNO_3
	1300		✓	OSGW-105	1	500ml			✓									HNO_3
	1300		✓	OSGW-105	1	1lg				✓								
	1330		✓	OSGW-ER	2	40ml	✓											HCl
	1330		✓	OSGW-ER	1	500ml		✓										HNO_3
	1330		✓	OSGW-ER	1	500ml			✓									HNO_3
✓	1330		✓	OSGW-ER	1	1lg				✓								

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Michael Schmidt			
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time

Remarks: 2 of 3

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. #

Project name: NAB-Little Creek

Samplers (Please print): Michael Schmidt / Anne Garibaldi

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	TOC	Total Lead	Dissolved Lead	Calcium, Magnesium, Bicarbonate								Remarks
5/14/93	1335		✓	05FB-101	2	40ml	✓											
	1335		✓	05FB-101	1	500ml		✓										
	1335		✓	05FB-101	1	500ml			✓									
	1335		✓	05FB-101	1	1l				✓								

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Remarks:
Michael Schmidt	5/14/93			3 of 3
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	

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CHAIN OF CUSTODY

Original chain of Custody goes to Laboratory

Proj. # CTO-42

Project name: NAB-Little Creek

Samplers (Please print): Paul Scian / Dennis Place

Date	Time	Comp.	Grab	Sample Identification	Type of container	Number of containers	TCL PCBs	TOC	Remarks
5/14	1627		✓	1655-101	4oz	1	✓	✓	
"	1630		✓	1655-102	"	1	✓	✓	
"	1632		✓	1655-103	"	1	✓	✓	
"	1633		✓	1655-104	"	1	✓	✓	
"	1635		✓	1655-105	"	1	✓	✓	
"	1636		✓	1655-106	"	1	✓	✓	
"	1640		✓	1655-107 / MS/MSD	"	1	✓	✓	
"	1642		✓	1655-108	"	1	✓	✓	
"	1644		✓	1655-109	"	1	✓	✓	
"	1650		✓	1655-110	"	1	✓	✓	
"	1652		✓	1655-111	"	1	✓	✓	
"	1705		✓	1655-ER	250ml	1		✓	Equipment Rinse
	1708		✓	1655-ER 1 through 4	4oz	4	✓		"

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Dennis Place	5/14/93		
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time

Remarks: 1 of 1

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1 of 2

№ 1672

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO - ØØ42

PROJECT NO.

SAMPLER(S) SIGNATURE Anne Garibaldi
Morgan I. Evans

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
12SW -101		6/28/93	0940	X					X	2-40ml 1-500ml	3	TCL VOC, TAL Metals(total)	→ HCl → HNO_3 Preserved
12SW -102		6/28/93	0951	X					X	↓	↓	↓	↓
12SW -103		6/28/93	1037	X					X	↓	↓	↓	↓
12SW -104		6/28/93	1114	X					X	↓	↓	↓	↓
12SED -102-00		6/28/93	0957		X				X	1-4oz 1-8oz	2	TCL VOC TAL Metals, TOC	
12SED -102-06		6/28/93	1015		X				X	↓	↓	↓	
12SED -103-00		6/28/93	1048		X				X	↓	↓	↓	
12SED -103-06		6/28/93	1103		X				X	↓	↓	↓	
12GW -101		6/28/93	1320	X					X	2-40ml	2	TCL VOC	→ HCL Preserved
12GW -102		6/28/93	1340	X					X	↓	↓	↓	↓
12GW -103		6/28/93	1350	X					X	↓	↓	↓	↓
12GW -104		6/28/93	1329	X					X	↓	↓	↓	↓
13													

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	[illegible]	6/28/93 1930	684 974 1930		
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

2 of 2

№ 1673(

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-ØØ42

PROJECT NO.

SAMPLER(S) SIGNATURE Anne Garibaldi
Morgan I Evans

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
13-SB-RB-101		6/28/93	1430	X					X	2-40ml 1-250ml 1-1000ml	4	TCL VOC, TCL SVOC, TOC	>HCl preserved
TB-F2-101		6/28/93	N/A	X					X	2-40ml	2	TCL VOC	Trip Blank
13-SB-105-01		6/28/93	1445		X				X	4-OZ(1) 8-OZ(1)	2	TCL VOC TCL SVOC, TOC	
13-SB-105-02		6/28/93	1502		X				X		↓	↓	
13-SB-108-01	MS/MSD	6/28/93	1445		X				X				MS/MSD
13-SB-109-02		6/28/93	1604		X				X				
13-SB-108-03		6/28/93	1521		X				X				

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	[illegible]	6/23/93 1730	6849941980		
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16717

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-22-55-192071

SAMPLER(S) SIGNATURE [illegible]

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
TB-P2-102		6/30/93	N/A							40ml(2)	2	TCL VOC	
11-[illegible]-102			0850								2		
BH10-107			1500							40ml(6)	~~26~~ 26		MS/MSD
10-[illegible]-109			0900							40ml(2)	2		
~~11-[illegible]-103~~			~~08~~										~~AR~~
11-[illegible]-101			0911								2		
11-[illegible]-103			0853								2		
11-[illegible]-10[illegible]			0915								~~2~~ ~~26~~ 26		~~MS/MSD~~
PB-RB-101			1350								2		
10-[illegible]-106			0915							40ml(6)	26		MS/MSD
13[illegible]B-RB-102			1255							40ml(2)	2		
10-[illegible]-107			1040								2		
10-[illegible]-102			0753								2		
10-[illegible]-101			1116								2		

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	[illegible]	6/30/93			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16716

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-22-55-192071

SAMPLER(S) SIGNATURE [illegible]

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
TB RB -101		6/30/93	1505							2(40ml)	2	TCL VOC	
10 [illegible] -105			0840							2(40ml)	2		
TB [illegible] -101			1625								2		
BMW- 8			1520								2		Also labelled ~~BW~~ BMW-108 on some coolers
BMW 11			1620								2		
05 [illegible] -107			1650							4oz	1	TCL VOC	
05 [illegible] -107			1705							4oz	1		
[illegible]			1635							4oz	1		
[illegible] -101			1620							4oz	1		
01 [illegible] -106			1515							2(40ml)	2		
02 [illegible] -07			1230								2		
[illegible] -103			1215								2		
01 [illegible]			1240								2		
01 [illegible]			1405								6		MS/MSD

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	[illegible]	6/30/93			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16716

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-32 55 [illegible]071

SAMPLER(S) SIGNATURE [illegible]

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
10-(1)-103	LC10-(1)-02	6/30/93	753	X					X	1000 ml	2 3 4	Total Metals, Dissolved Metals, ~~VOA~~	ME
10-(1)-105	LC10-(1)-05	6/30/93	840	X					X	1000 ml	2 3 4	Total Metals, Dissolved Metals, ~~VOA~~	ME
10-(1)-106	LC10-(1)-06	6/30/93	915	X					X	1000 ml	2 3 4	Total Metals, ~~VOA~~, Dissolved Metals	ME
10-(1)-107	LC10-(1)-07	6/30/93	1040	X					X	1000 ml	2 3 4	Total Metals, ~~VOA~~, Dissolved Metals	ME
10-(1)-101	LC10-(1)-01	6/30/93	1116	X					X	1000 ml	2 3 4	Total Metals, ~~VOA~~, Dissolved Metals	ME
10-(1)-109	LC10-(1)-09 ~~9-UST-3~~	6/30/93	900	X					X	1000 ml	2 3 4	Total Metals, ~~VOA~~, Dissolved Metals	ME
10-[illegible]	[illegible]	[illegible]	915	X					X	1000 ml	2 3 4	Total Metals, ~~VOA~~, Dissolved Metals	ME
[illegible]	[illegible]	[illegible]	915	X					X	1000 ml	2 3 4	Total Metals, ~~VOA~~, Dissolved Metals	ME
09-(1)-103	9-UST-03	6/30/93	1215	X					X	1500 ml	3 5	Total Metals, Anions, Dissolved Metals, ~~VOA~~	ME
09-(1)-102	LC9-(1)-02	6/30/93	1240	X					X	1500 ml	3 5	Total Metals, Anions, Dissolved Metals, ~~VOA~~	ME
09-[illegible]-107	LC9-(1)-07	6/30/93	1230	X					X	1500 ml	3 5	Total Metals, Anions, Dissolved Metals, ~~VOA~~	ME
09-[illegible]	LC9-(1)-04	6/30/93	1425	X					X	1500 ml	3 5	Total Metals, Anions, Dissolved Metals, ~~VOA~~	ME
09-(1)-104	LC9-(1)-04	6/30/93	1425	X					X	1500 ml	3 5	Total Metals, Anions, Dissolved Metals, ~~VOA~~	ME
09-(1)-[illegible]	LC9-(1)-04	6/30/93	1425	X					X	1500 ml	3 5	Total Metals, Anions, Dissolved Metals, ~~VOA~~	ME

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	[illegible]	6/30/93			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

FORM NO. 4541-03

№ 1671(

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-22-55-192071

SAMPLER(S) SIGNATURE Morgan T. Evans

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
09-GW-106	LC9-GW-06	6/30/93	1515	X					X	~~1540~~ ~~830~~ ml	~~5~~ 3	Total Metals, Anions, Dissolved Metals	
05-SS-101	LC5-SS-01	6/30/93	1620	~~X~~	X				X	8 oz.	1	Total Organic Carbon	
05-SS-102	LC5-SS-02	6/30/93	1635		X				X	8 oz.	1	Total Organic Carbon	
05-SS-103	LC5-SS-03	6/30/93	1650		X				X	8 oz.	1	Total Organic Carbon	
05-SS-104	LC5-SS-04	6/30/93	1705		X				X	8 oz.	1	Total Organic Carbon	
													6/30/93

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	Morgan T. Evans	6/30/93			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16711

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-22-55-192071

SAMPLER(S) SIGNATURE [signature]

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
BMW-107	BACK	6/30/93	1510	X							3	TPH	1 sample + 2 MS/MSD
BMW 107	BACKGROUND	"	1455	X							3	BNA, PEST, PCB	1 sample + 2 MS/MSD
BMW 107	"	"	1547	X							3	METALS (DISSOLVED)	1 sample + 2 MS/MSD
BMW-107	"	"	1520	X							3	Cyanide	" "
BMW 107	"	"	1525	X							3	Metals (TOTAL)	" "
HGW-101	SITE 11	6/30/93	0911	X							1	METALS (TOTAL)	
HGW-101	"	"	0911	X							1	METALS (DISSOLVED)	
HGW-102	"	"	0850	X							1	METALS (TOTAL)	
HGW-102	"	"	0850	X							1	METALS (DISS)	
HGW-103	"	"	0853	X							1	METALS (TOTAL)	
HGW-103	"	"	0853	X							1	METALS (DISS)	

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	James Emery	6/30/93 1900			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16720

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-22-55-192071

SAMPLER(S) SIGNATURE J.M. Emery

P. 1 of 2 [see № 16720]

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
BMW-8	BACKGROUND	6/30/93	1630	X							1	BNA, Pest PCB	ALSO BMW-108
BMW-11DUP	"	"	1630	X								"	DUPLICATE OF "8"
BMW-8	"	"	1630	X								TPH	ALSO BMW-108
BMW-11DUP	"	"	1630	X								TPH	Duplicate of 8
BMW-8	"	"	1640	X								Cyanide	also BMW-108
BMW-11DUP	"	"	1640	X								"	Dup of 8
BMW-8	"	"	1635	X								Metals (TOTAL)	also BMW-108
BMW-11DUP	"	"	1635	X								"	Dup of 8
BMW-8	"	"	1648	X								METALS (Dissolved)	Also BMW-108
BMW-11DUP	"	"	1648	X								"	Dup of 8
FB-PZ-101	QA/QC	"	1625	X								METALS (DISSOLVED)	FIELD BLANK
PB-RB-101	"	"	1350	X								METALS (DISSOLVED)	(POLY BAILER) RINSE BLANK
TB-RB-101	"	"	1505	X							(DISSOLVED)	METALS ([redacted])	(TEFLON BAILER) RINSE BLANK
PB-RB-101	"	"	1350	X							1	METALS (TOTAL)	(POLY BAILER) RINSE BLANK

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1					
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16721

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-22-55-192071

SAMPLER(S) SIGNATURE J.M. Emery P. 2 of 2 [SEE № 16720]

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
TB-RB-101	QA/QC	6/30/93	1505	X							1	METALS (TOTAL)	Teflon RINSE BLANK
FB P2-101	"	"	1625	X								METALS (TOTAL)	FIELD BLANK
135SB-RB-102	"	"	1255	X								METALS (TOTAL)	RINSE BLANK
FB-P2-101	"	"	1625	X								BNA, PEST, PCB	FIELD BLANK
TB-RB-101	"	"	1505	X								"	RINSE BLANK
FB-P2-101	"	"	1625	X								ANIONS	FIELD BLANK
RB-RB-101	"	"	1350	X								"	RINSE BLANK
FB P2-101	"	"	1625	X								Cyanide	FIELD BLANK
TB-RB-101	"	"	1505	X								"	RINSE BLANK
135SB-RB102	"	"	1255	X								BNA, Pest, PCB	RINSE BLANK
FB-P2-101		"	1625	X								TPH	FIELD BLANK
TB-RB-101		"	1505	X								"	RINSE BLANK
FB-P2-101		"	1625	X								TOC	FIELD BLANK
135SB-RB-102		"	1255	X								"	RINSE BLANK

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	James Emery	6/30/93 1900			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16725

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 422-55-192071

SAMPLER(S) SIGNATURE

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
07SW -106		7/1/93	1405	X						2,080ml ~~2800ml~~	4	TCL VOC, Anions TAL Metals (total)	
07SED -RB-101		↓	1330		X					2,040ml	3	TCL VOC, Anions Total Metals	
07SW -105		7/1/93	1345	X						1 oz	2	TCL VOC, Anions TAL Metals (total), TOC	
07SW -107			1310 ~~1305~~	X						2,080ml	4	↓	MS/MSD
07-SW -103			1240	X						2,080ml	4	↓	
07-SED -104			1305		X					1 oz	2	TCL VOC Anions, TAL Metals, TOC	
07-SED -105			1345		X					1 oz	2	↓	
07-SED -106			1405		X					1 oz	2	↓	
07-SED -107			1305		X					1 oz	2	↓	
07-GW -103			1240	X						3,080ml	3	TCL VOC, Anions, Total + Dissolved TAL metals	
07-~~GW~~ GW-102			1340	X						3,080ml	3	↓	Also labelled C7-GW2
07SED -101			1153		X					1 oz	~~2~~ 4	TCL VOC, Anions, TAL Metals, TOC	MS/MSD
07~~SW~~SED -102			1220		X					↓	2	↓	
07 SED -103		↓	1240		X				↓	↓	2	↓	

RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1				
EXCHANGE #2				
EXCHANGE #3				

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 1672

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-22-55-192071

SAMPLER(S) SIGNATURE

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
07SW -101		7/1/93	1150	X						2,080 ml	4	TCL VOA, Total Metals, Anions	
07SW -102			1220	X									
07SW -104			1305	X									
07GW -104			1535	X						3,080 ml	5	TCL VOA, Total + Dissolved Metals, Anions	
BMW 3			0715	X						1000 ml	1	BNA, Pest/AIDs	
BMW 11			0715	X							1		
BMW 107			0725	X							3		MS/MSD

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1					
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16726

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-113

PROJECT NO. [illegible]

SAMPLER(S) SIGNATURE Morgan Grass

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE				COMP	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
				WATER	SOLID	AIR	OIL						
07 [illegible]	[illegible]	[illegible]/93	920	X					X	1500	3	Total Metals Anions, Dissolved Metals	
07-(-1) 107	[illegible]	07/[illegible]/93	1137	X					X	1500	3	Total Metals Anions Dissolved Metals	
07 (-1) 103	[illegible]	[illegible]	1155	X					X	1500	3	Total Metals, Anions Dissolved Metals	
07-(-1) 109	[illegible]	[illegible]	1115	X					X	1500	3	Total Metals Anions Dissolved Metals	
07 [illegible]	[illegible]	[illegible]	1240	X					X	1500	3	Total Metals, Anions [illegible]	

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	[illegible]	[illegible]			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16727

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 11-22-55-192071

SAMPLER(S) SIGNATURE Morgan Evans

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
07-(-1)-107	LC7-(-1)-3	07/01/93	920	X					X	80ml	2	VOA	
07-(-1)-107	LC7-(-1)-7	07/01/93	1137	X					X	80ml	2	VOA	
07-(-1)-108	LC7-(-1)-8	07/01/93	1155	X					X	80ml	2	VOA	
07-(-1)-109	LC7-(-1)-9	07/01/93	1145	X					X	80ml	2	VOA	
07-[illegible]	LC7-(-1)-6	07/01/93	1240	X					X	80ml	2	VOA	

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	[illegible]	07/01/93			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16723

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-22-55-19207

SAMPLER(S) SIGNATURE Morgan Evans

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
BMW-1	BMW-1	07/02/93	922	X					X	5080	8	VOA, Total Metals, SVOC, PCBs/Pesticides Dissolved Metals, Cyanide TPH	
BMW-2	BMW-2	07/02/93	950	X					X	5080	8	VOA, Total Metals, SVOC, PCBs/Pesticides Dissolved Metals, Cyanide TPH	
BMW-3	BMW-3	07/02/93	1250	X					X	40	1	VOA	
TB-05	CTO-42	07/02/93	1330	X						80	2	VOA	

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	Morgan Evans	07/02/93 1400			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 1671

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4-22-55-192071

SAMPLER(S) SIGNATURE [signature]

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
BMW-105		7/2/93	1157	X						5080 ml	5	TCL, VOC, Total & dissolved metal, BNA, Pest/PCB, TPH, cyanide	
BMW-104		7/2/93	1200	X						5080 ml	5	↓	
BMW-106		7/2/93	0828	X						5080 ml	5	↓	
TB [illegible]-103		7/2/93	N/A	X						80 ml	2	TCL VOC	

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	[signature]	7/2/93			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 1670

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 4.22.55.192071

SAMPLER(S) SIGNATURE Morgan Evans

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
LC10-GW106	LC10-GW 6	07/14/93	0735	X					X	1000ml	1	Anions	
LC10-GW105	LC10-GW 5	07/14/93	0745	X					X	1000ml	1	Anions	
LC10-GW102	LC10-GW 2	07/14/93	0805	X					X	1000ml	1	Anions	
LC10-GW-107	LC10-GW 7	07/14/93	0825	X					X	1000ml	1	Anions	
LC10-GW-101	LC10-GW 1	07/14/93	0845	X					X	1000ml	1	Anions	
07SB9D	07SB9D	07/13/93	1346		X				X	28oz	4	VOA TPH Pest/PCB/BNA Metals/CN	
07SB6D	07SB6D	07/14/93	1055		X				X	28oz	4	VOA TPH Pest/PCB/BNA Metals/CN	
07-ERB-05	Site 7	07/14/93	1630	X					X	4580ml	7	BNA, Pest-PCB, TPH, CN, Metals, VOA	
07-FB-05	Site 7	07/14/93	1700	X					X	4580ml	7	BNA, Pest/PCB, TPH, CN, Metals, VOA	
07-TB-06	Trip Blank Site 7	07/14/93	1700	X					X	80ml	2	VOA	

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	Morgan Evans	07/14/93			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 1670

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME CTO-42

PROJECT NO. 11.22.55.192071

SAMPLER(S) SIGNATURE Morgan Evans

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
07-SB-01D	07-SB-01D	07/16/93	1945		X				X	28oz	4	VOA, BNA, PCB, Pest, Metals/CN TPH	
07-EBB-07	Site 7	07/16/93	1100	X					X	4580	7	VOA, BNA, PCB/PEST METALS/CN TPH	

	RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1	Morgan Evans	07/16/93			
EXCHANGE #2					
EXCHANGE #3					

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

№ 16191

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME Little Creek RI/FS

PROJECT NO. (70-42 4-22-55-192071

SAMPLER(S) SIGNATURE Mike Schmidt
Nat Apte

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
13GW08	Site 13 MW-8	7/29/93	14:30						✓	1 lt	ONE Amber	SVOCs	
13GW09	Site 13 MW-9		17:30						✓	amber			Sample container received Broken
13GW03	MW-3		15:20						✓	bottle			
13GW03MS	MW-3		15:20						✓				
13GW03MSD	MW-3		15:20						✓				
13GWFB	Field Blank		15:30						✓				
13GWERB	Rinsate Blank		15:45						✓				
13GW06	Site 13 MW-6		15:50						✓				
13GW04	MW-4		16:40						✓				
13GW07	MW-7		17:10						✓				
13GW05	MW-5		1735						✓				
07GW05	Site 7, MW-5		1850						✓				
									✓				

RELINQUISHED BY: NAME | DATE/TIME | CARRIER/WAYBILL # | RECEIVED BY: NAME | DATE/TIME

EXCHANGE #1

EXCHANGE #2

EXCHANGE #3

AUTHORIZATION FOR DISPOSAL | DATE/TIME | DISPOSED BY: | DATE/TIME

7/30/93 10:30

№ 16192

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME Little Creek RI/FS

PROJECT NO. CTO-42, 4-22-55-192071

SAMPLER(S) SIGNATURE Mike Schmidt
Nitin Apte

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
13GW08	Site 13 MW-8	7/29	14:30							40ml	2	VOCs	HCl
13GW09	MW-9		17:30										
13GW03	MW-3		15:20										
13GW03MS	MW-3		15:20										
13GW03MSD	MW-3		15:20										
13GWFB	Field Blank		15:30										
13GWFRB	Rinsate Blank		15:45										
13GW06	Site 13 MW-6		15:50										
13GW04	MW-4		16:40										
13GW07	MW-7		17:10										
13GW05	MW-5		1735										
07GW05	Site 7 MW-5		1850										
13GWTB	Trip Blank												

RELINQUISHED BY: NAME

EXCHANGE #1

EXCHANGE #2

EXCHANGE #3

DATE/TIME

CARRIER/WAYBILL #

RECEIVED BY: NAME [signature]

DATE/TIME 7/30/93 10:30

AUTHORIZATION FOR DISPOSAL

DATE/TIME

DISPOSED BY:

DATE/TIME

not signed

№ 16193

FW ENVIRESPONSE, INC.

CHAIN OF CUSTODY RECORD

PROJECT NAME Little Creek RI/FS

PROJECT NO. CTU-42, 4-22-55-192071

SAMPLER(S) SIGNATURE Mike Schmidt, Nidin Apte

SAMPLE IDENTIFICATION	SAMPLING LOCATION	DATE SAMPLED	TIME SAMPLED	SAMPLE TYPE: WATER	SOLID	AIR	OIL	COMP.	GRAB	VOLUME COLLECTED	NO. OF CONTAINERS	ANALYSIS	COMMENTS
07GWFB	Field Blank	7/29	16:00							500ml	1 poly	Metals	HNO_3 ~~HCl~~
07GWFB	Field Blank		16:00									Cyanide/Anions	4°C
07GWERB	Rinsate Blank		16:00									Metals	HNO_3 ~~HCl~~
07GWERB	Rinsate Blank		16:00									Cyanide/Anions	4°C
Site 7 MW-5	07GW05		18:50									Metals	HNO_3 ~~HCl~~
— " —	07GW05		18:50									Metals	(filtered) ~~HCl~~ HNO_3
07GW05	Site 7 Well 5		18:50									Cyanide/Anions	4°C

RELINQUISHED BY: NAME	DATE/TIME	CARRIER/WAYBILL #	RECEIVED BY: NAME	DATE/TIME
EXCHANGE #1			[illegible]	7/30/93 10:30
EXCHANGE #2				
EXCHANGE #3				

AUTHORIZATION FOR DISPOSAL _____ DATE/TIME _____ DISPOSED BY: _____ DATE/TIME _____

APPENDIX H

Shelby Tube Analysis

McCALLUM
TESTING LABORATORIES INC.
Subsurface Exploration • Geotechnical Engineering

June 7, 1993

Foster Wheeler Enviresponse, Inc.
8 Peach Tree Hill Road
Livingston, NJ 07039

Attention: Mr. Dennis Place

Subject: Laboratory Test Results - 5/12/93
Navy Clean UST Site Characterization #CTO-~~0163~~ 0042 ~~AB~~ 10/25/93
Little Creek Amphibious Base
Virginia Beach, Virginia
P.O. #VN2-422-166004
MTL Project 93-1188

Dear Mr. Place:

Attached are the results of Hydrometer / Grain Size Analysis Tests (ASTM D 422), Atterberg Limits Tests (ASTM D 4318), Specific Gravity of Soils Tests (ASTM D 854), and Constant Head Permeability Tests (ASTM D 2434) performed on undistributed samples obtained from the above referenced project.

Should you have any questions concerning this report, please contact this office at your convenience.

Very truly yours,

McCALLUM TESTING LABORATORIES, INC.

Kenneth K. Ward
Laboratory Manager

Douglas S. Kinloch, P.E.
Chief Engineer

COMMONWEALTH OF VIRGINIA
DOUGLAS S. KINLOCH
No. 7969
CERTIFIED PROFESSIONAL ENGINEER

1808 HAYWARD AVENUE P.O. BOX 13337 CHESAPEAKE, VIRGINIA 23325-0
TELEPHONE (804) 420-2520 • FAX (804) 424-2874

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1188
Client's Order No.
Client's Req'n No.
Date 6/7/93

REPORT ON SOIL

Lab. No. 34-1 Chesapeake, Va.
Sample of Proposed Use
Sample No. 07ST-102/UD-1 From Navy Clean UST Site Characterization #CTO-~~0163~~ 0042
Depth Taken Depth From 0' to 2'
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled 5/12/93 Received

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE

SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%
2"-1½"	%	2"	%
1½"-1"	%	1½"	%
1"-¾"	%	1"	%
¾"-½"	8.4 %	¾"	100.0 %
½"-3/8"	6.2 %	½"	91.6 %
3/8"-#4	10.0 %	3/8"	85.4 %
Passing #4	%	#4	75.4 %

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	9.3 %	# 4	75.4
Medium Sand #10-#40	23.2 %	# 10	66.1
Fine Sand #40-#200	21.3 %	# 40	42.9
Silt #200—0.005 mm	17.1 %	#100	29.3
Clay-Smaller than 0.005 mm	4.5 %	#200	21.6
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

Liquid Limit N/A (ASTM D 4318) Water Content as Received 27.8 (ASTM D 2216)
Plastic Limit N/A (ASTM D 4318) Plasticity Index NP (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity 2.30 (ASTM D 854) Coefficient of permeability 7.3×10^{-4} cm/sec (ASTM D 24
Classification SM (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Visual Description of Sample: Very dark grey silty fine to coarse sand and fly ash with gravel, glass and traces of organics

Insitu Wet Unit Weight (pcf): 87.3

Insitu Dry Unit Weight (pcf): 68.3

Lab. No.

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FORM L-111

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1188
Client's Order No.
Client's Req'n No.
Date 6/7/93

REPORT ON SOIL

Lab. No. 34-2 Chesapeake, Va.
Sample of Proposed Use de 10/25/9
Sample No. 07ST-101/UD-2 From Navy Clean UST Site Characterization #CTO-~~0163~~ 004
Depth Taken Depth From 0' to 2'
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled 5/12/93 Received

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE

SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%
2"-1½"	%	2"	%
1½"-1"	%	1½"	%
1"-¾"	%	1"	%
¾"-½"	%	¾"	%
½"-3/8"	%	½"	%
3/8"-#4	%	3/8"	%
Passing #4	%	#4	%

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	.3 %	# 4	100.0
Medium Sand #10-#40	14.1 %	# 10	99.7
Fine Sand #40-#200	56.2 %	# 40	85.6
Silt #200—0.005 mm	18.8 %	#100	56.0
Clay-Smaller than 0.005 mm	10.6 %	#200	29.4
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

Liquid Limit 21 (ASTM D 4318) Water Content as Received 13.2 (ASTM D 2216)
Plastic Limit 13(ASTM D 4318) Plasticity Index 8 (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity 2.63 (ASTM D 854) Coefficient of permeability 2.0×10^{-3} cm/sec. (ASTM D
Classification SC (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Visual Description of Sample: Greyish brown silty clayey fine sand
Insitu Wet Unit Weight (pcf): 113.5
Insitu Dry Unit Weight (pcf): 100.3

Lab. No.

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McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1188
Client's Order No.
Client's Req'n No.
Date 6/7/93

REPORT ON SOIL

Lab. No. 34-3 Chesapeake, Va.
Sample of Proposed Use dd 10/25/93
Sample No. 10ST-102/UD-3 From Navy Clean UST Site Characterization #CTO-~~0163~~ 0042
Depth Taken Depth From 0' to 2'
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled 5/12/93 Received

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE				SOIL MORTAR			
SIEVE ANALYSIS		TOTAL % PASSING		SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%	Coarse Sand #4-#10	0.4 %	# 4	99.8
2"-1½"	%	2"	%	Medium Sand #10-#40	37.2 %	# 10	99.4
1½"-1"	%	1½"	%	Fine Sand #40-#200	51.7 %	# 40	62.2
1"-¾"	%	1"	%	Silt #200—0.005 mm	7.7 %	#100	16.1
¾"-½"	%	¾"	%	Clay-Smaller than 0.005 mm	2.8 %	#200	10.5
½"-3/8"	%	½"	%	Colloids-Smaller than 0.001 mm	%		
3/8"-#4	.2 %	3/8"	100.0 %				
Passing #4	99.8 %	#4	99.8 %				

OTHER TEST DATA

Liquid Limit N/A (ASTM D 4318) Water Content as Received 14.1 (ASTM D 2216)
Plastic Limit N/A (ASTM D 4318) Plasticity Index NP (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity 2.57 (ASTM D 854) Coefficient of permeability 2.1×10^{-3} cm/sec. (ASTM D 2
Classification SP-SM (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Visual Description of Sample: Dark greyish brown silty fine to medium sand w/traces of
situ Wet Unit Weight (pcf): 112.3
Insitu Dry Unit Weight (pcf): 98.4

Lab. No.

Our letters and reports are for the exclusive use of the client to whom they are addressed. The use of our name must receive our prior written approval. Our lette reports apply only to the sample tested and/or inspected, and are not necessarily indicative of the qualities of apparently identical or similar products.

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1188
Client's Order No.
Client's Req'n No.
Date 6/7/93

REPORT ON SOIL

Lab. No. 34-4 Chesapeake, Va.
Sample of Proposed Use 10/25/93
Sample No. 10ST-103/UD-4 From Navy Clean UST Site Characterization #CTO ~~0163~~ 004
Depth Taken Depth From 0' to 2'
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled 5/12/93 Received

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE

SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%
2"-1½"	%	2"	%
1½"-1"	%	1½"	%
1"-¾"	%	1"	%
¾"-½"	%	¾"	%
½"-3/8"	%	½"	%
3/8"-#4	.3 %	3/8"	100.0 %
Passing #4	99.7 %	#4	99.7 %

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	5.5 %	# 4	99.7
Medium Sand #10-#40	57.4 %	# 10	94.2
Fine Sand #40-#200	31.1 %	# 40	36.8
Silt #200—0.005 mm	3.2 %	#100	9.0
Clay-Smaller than 0.005 mm	2.5 %	#200	5.7
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

Liquid Limit N/A (ASTM D 4318) Water Content as Received 3.1 (ASTM D 2216)
Plastic Limit N/A (ASTM D 4318) Plasticity Index N/P (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity 2.65 (ASTM D 854) Coefficient of permeability 3.4×10^{-2} cm/sec. (ASTM D 2
Classification SP-SM (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Visual Description of Sample: Light brown fine to medium sand with traces of coarse sand

Insitu Wet Unit Weight (pcf): 115.6

Insitu Dry Unit Weight (pcf): 112.1

Lab. No.

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McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1188
Client's Order No.
Client's Req'n No.
Date 6/7/93

REPORT ON SOIL

Lab. No. 34-5 Chesapeake, Va.
Sample of Proposed Use
Sample No. 09ST-102/UD-5 From Navy Clean UST Site Characterization #CTO-~~0163~~-0042
Depth Taken Depth From 0' to 2'
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled 5/12/93 Received

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE

SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%
2"-1½"	%	2"	%
1½"-1"	%	1½"	%
1"-¾"	%	1"	%
¾"-½"	%	¾"	%
½"-3/8"	%	½"	%
3/8"-#4	%	3/8"	%
Passing #4	%	#4	%

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	0.0 %	# 4	100.0
Medium Sand #10-#40	48.1 %	# 10	100.0
Fine Sand #40-#200	50.4 %	# 40	51.9
Silt #200—0.005 mm	0.6 %	#100	3.79
Clay-Smaller than 0.005 mm	0.9 %	#200	1.5
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

Liquid Limit N/A (ASTM D 4318) Water Content as Received 3.0 (ASTM D 2216)
Plastic Limit N/A (ASTM D 4318) Plasticity Index N/P (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity 2.64 (ASTM D 854) Coefficient of permeability 3.6×10^{-2} cm/sec. (ASTM D 2
Classification SP (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Visual Description of Sample: Light brown silty fine sand
Insitu Wet Unit Weight (pcf): 110.7
Insitu Dry Unit Weight (pcf): 107.5

Lab. No.

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McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1188
Client's Order No.
Client's Req'n No.
Date 6/7/93

REPORT ON SOIL

Lab. No. 34-6 Chesapeake, Va.
Sample of Proposed Use AL 10/25/9
Sample No. 09ST-101/UD-6 From Navy Clean UST Site Characterization #CTO-~~0163~~ 0046
Depth Taken Depth From 0' to 2'
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled 5/12/93 Received

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE				SOIL MORTAR			
SIEVE ANALYSIS		TOTAL % PASSING		SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%	Coarse Sand #4-#10	0.6 %	# 4	100.0
2"-1½"	%	2"	%	Medium Sand #10-#40	22.6 %	# 10	99.4
1½"-1"	%	1½"	%	Fine Sand #40-#200	65.5 %	# 40	76.8
1"-¾"	%	1"	%	Silt #200—0.005 mm	8.5 %	#100	14.6
¾"-½"	%	¾"	%	Clay-Smaller than 0.005 mm	2.8 %	#200	11.3
½"-3/8"	%	½"	%	Colloids-Smaller than 0.001 mm	%		
3/8"-#4	%	3/8"	%				
Passing #4	%	#4	%				

OTHER TEST DATA

Liquid Limit N/A (ASTM D 4318) Water Content as Received 7.2 (ASTM D 2216)
Plastic Limit N/A (ASTM D 4318) Plasticity Index N/P (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity 2.63 (ASTM D 854) Coefficient of permeability 7.2×10^{-3} cm/sec. (ASTM D 2
Classification SP-SM (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Visual Description of Sample: Brown silty fine to medium sand
Insitu Wet Unit Weight (pcf): 103.6
Insitu Dry Unit Weight (pcf): 96.6

Lab. No.

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McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1188
Client's Order No.
Client's Req'n No.
Date 6/7/93

REPORT ON SOIL

Lab. No. 34-7 Chesapeake, Va.
Sample of Proposed Use AB 10/25
Sample No. 07ST-104/UD-7 From Navy Clean UST Site Characterization #CTO ~~0163~~ 0042
Depth Taken Depth From 0' to 2'
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled 5/12/93 Received

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE				SOIL MORTAR			
SIEVE ANALYSIS		TOTAL % PASSING		SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%	Coarse Sand #4-#10	0.1 %	# 4	100.0
2"-1½"	%	2"	%	Medium Sand #10-#40	11.1 %	# 10	99.9
1½"-1"	%	1½"	%	Fine Sand #40-#200	60.5 %	# 40	88.8
1"-¾"	%	1"	%	Silt #200—0.005 mm	21.5 %	#100	55.5
¾"-½"	%	¾"	%	Clay-Smaller than 0.005 mm	6.8 %	#200	28.3
½"-3/8"	%	½"	%	Colloids-Smaller than 0.001 mm	%		
3/8"-#4	%	3/8"	%				
Passing #4	%	#4	%				

OTHER TEST DATA

Liquid Limit 21 (ASTM D 4318) Water Content as Received 12.9 (ASTM D 2216)
Plastic Limit 13 (ASTM D 4318) Plasticity Index 8 (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity 2.66 (ASTM D 854) Coefficient of permeability 2.9×10^{-4} cm/sec. (ASTM D 2
Classification SC (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Visual Description of Sample: Greyish brown silty clayey fine sand

Insitu Wet Unit Weight (pcf): 121.7

Insitu Dry Unit Weight (pcf): 107.8

Lab. No.

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McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1188
Client's Order No.
Client's Req'n No.
Date 6/7/93

REPORT ON SOIL

Lab. No. 34-8 Chesapeake, Va.
Sample of Proposed Use AR 10/25/93
Sample No. 10ST-101/UD-8 From Navy Clean UST Site Characterization #CTO-~~0163~~- 0042
Depth Taken Depth From 0' to 2'
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled 5/12/93 Received

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE

SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%
2"-1½"	%	2"	%
1½"-1"	%	1½"	%
1"-¾"	%	1"	%
¾"-½"	%	¾"	%
½"-3/8"	%	½"	%
3/8"-#4	0.4 %	3/8"	100.0 %
Passing #4	99.6 %	#4	99.6 %

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	1.9 %	# 4	99.6
Medium Sand #10-#40	53.9 %	# 10	97.7
Fine Sand #40-#200	41.2 %	# 40	43.8
Silt #200—0.005 mm	2.2 %	#100	5.6
Clay-Smaller than 0.005 mm	0.4 %	#200	2.6
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

Liquid Limit N/A (ASTM D 4318) Water Content as Received 3.7 (ASTM D 2216)
Plastic Limit N/A (ASTM D 4318) Plasticity Index N/P (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity 2.66 (ASTM D 854) Coefficient of permeability 1.0×10^{-2} cm/sec. (ASTM D 2
Classification SP (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Visual Description of Sample: Greyish brown silty fine to medium sand
Insitu Wet Unit Weight (pcf): 117.5
Insitu Dry Unit Weight (pcf): 113.3

Lab. No.

Our letters and reports are for the exclusive use of the client to whom they are addressed. The use of our name must receive our prior written approval. Our left reports apply only to the sample tested and/or inspected, and are not necessarily indicative of the qualities of apparently identical or similar products.

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1188
Client's Order No.
Client's Req'n No.
Date 6/7/93

REPORT ON SOIL

Lab. No. 34-9 Chesapeake, Va.
Sample of Proposed Use AP 10/25/93
Sample No. 07ST-103/UD-9 From Navy Clean UST Site Characterization #CTO-~~0163~~ 004
Depth Taken Depth From 0' to 2'
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled 5/12/93 Received

MECHANICAL ANALYSIS (ASTM D 422)

COARSE AGGREGATE

SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%
2"-1½"	%	2"	%
1½"-1"	%	1½"	%
"-¾"	%	1"	%
¾"-½"	%	¾"	%
½"-3/8"	%	½"	%
3/8"-#4	%	3/8"	%
Passing #4	%	#4	%

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	1.5 %	# 4	100.0
Medium Sand #10-#40	25.9 %	# 10	98.5
Fine Sand #40-#200	33.2 %	# 40	72.6
Silt #200—0.005 mm	28.3 %	#100	50.7
Clay-Smaller than 0.005 mm	11.1 %	#200	39.4
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

Liquid Limit 13 (ASTM D 4318) Water Content as Received 15.6 (ASTM D 2216)
Plastic Limit 13 (ASTM D 4318) Plasticity Index 0 (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity 2.56 (ASTM D 854) Coefficient of permeability 6.1×10^{-5} cm/sec. (ASTM D 2
Classification SM (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Visual Description of Sample: Dark brown silty fine to medium sand with clay lenses and organics

Insitu Wet Unit Weight (pcf): 124.8

Insitu Dry Unit Weight (pcf): 108.0

Lab. No.

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McCALLUM
TESTING LABORATORIES INC
Subsurface Exploration • Geotechnical Engineerin

September 9, 1993

Foster Wheeler Enviresponse, Inc.
8 Peach Tree Hill Road
Livington, NJ 07039

Subject: Laboratory Test Results
Little Creek Amphibious Base
Virginia Beach, Virginia
S.O. No. 19042-62-SVZ
MTL Project 93-1270

Gentlemen:

Attached are the results of laboratory tests performed on an undisturbed sample of cap material taken from Site #7 at the Little Creek Amphibious Base. Included in this report are results of a Percent Finer Than a #200 Sieve Test (ASTM D 1140), an Atterberg Limits Test (ASTM D 4318) and a Permeability Test (ASTM D 5084).

Should you have any questions concerning this report, please contact this office at your convenience.

Very truly yours,

McCALLUM TESTING LABORATORIES, INC.

Douglas S. Kinloch, P.E.
Chief Engineer

COMMONWEALTH OF VIRGINIA
S. KINLOCH
No. 7998
CERTIFIED PROFESSIONAL ENGINEER

Post-It™ brand fax transmittal memo 7671 | # of pages ▸ 2

To Nitin Apte	From
Co.	Co. MTL
Dept.	Phone # 420-2520
Fax # 201-535-2423	Fax # 424-2874

McCallum Testing Laboratories, Inc.
1808 HAYWARD AVENUE
P.O. Box 13337
CHESAPEAKE, VIRGINIA 23325-0266
(804) 420-2520

Our File Number 93-1270
Client's Order No.
Client's Req'n No.
Date 9/8/93

REPORT ON SOIL

Lab. No. 61 Chesapeake, Va.
Sample of Soil Cap Material Proposed Use
Sample No. From Little Creek, S.O. No. 19042-62-SVZ, Site #7
Depth Taken Depth From to
Depth of Cut Height of Fill Represents
Submitted by Foster Wheeler Enviresponse, Inc.
Sampled Received 6/28/93

MECHANICAL ANALYSIS

COARSE AGGREGATE

SIEVE ANALYSIS		TOTAL % PASSING	
3"-2"	%	3"	%
2"-1½"	%	2"	%
1½"-1"	%	1½"	%
1"-¾"	%	1"	%
¾"-½"	%	¾"	%
½"-3/8"	%	½"	%
3/8"-#4	%	3/8"	%
Passing #4	%	#4	%

SOIL MORTAR

SIEVE ANALYSIS		TOTAL % PASSING	
Coarse Sand #4-#10	%	# 4	
Medium Sand #10-#40	%	# 10	
Fine Sand #40-#200	%	# 40	
Silt #200—0.005 mm	%	#100	
Clay-Smaller than 0.005 mm	%	#200	99.3
Colloids-Smaller than 0.001 mm	%		

OTHER TEST DATA

Liquid Limit 47 (ASTM D 4318) Water Content as Received 46.8 (ASTM D 2216)
Plastic Limit 22 (ASTM D 4318) Plasticity Index 25 (ASTM D 4318) Loss on Ignition (corrected)
Specific Gravity N/A (ASTM D 854) Coefficient of permeability 2.9×10^{-8} cu.cm./sec.
Classification CL (ASTM D 2487) H.R.B.

Remarks: Sample Contained

Lab. No.

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APPENDIX I

Geoprobe Survey by TARGET ENVIRONMENTAL

TARGET ENVIRONMENTAL SERVICES, INC.

May 21, 1993

Mr. Peter Kossis
Baker Environmental, Inc.
420 Rouser Road, Building 3
Coraopolis, Pennsylvania 15108

Dear Mr. Kossis:

Enclosed please find one (1) copy of the report on the Site Screening Data collected by TARGET at the NAB Little Creek site in Virginia Beach, Virginia. One (1) copy of this report was sent to Nitin Apte at Foster Wheeler.

If you have any questions or comments about this report, please give me a call at (410) 992-6622. We appreciate the opportunity to provide our services to you on this project.

Sincerely,

TARGET ENVIRONMENTAL SERVICES, INC.

Timothy W. Niblett
Senior Project Manager

TWN/csm

Enclosure

cc: Nitin Apte

9180 RUMSEY ROAD, COLUMBIA, MARYLAND 21045 (410) 992-6622 Fax (410) 992-0347

SITE SCREENING DATA

NAB LITTLE CREEK
VIRGINIA BEACH, VIRGINIA
CTO 19042

PREPARED FOR

BAKER ENVIRONMENTAL, INC.
420 ROUSER ROAD, BUILDING 3
CORAOPOLIS, PENNSYLVANIA 15108

PREPARED BY

TARGET ENVIRONMENTAL SERVICES, INC.
9180 RUMSEY ROAD
COLUMBIA, MARYLAND 21045
(410) 992-6622

MAY 1993

SAMPLE COLLECTION AND ANALYSIS

On May 10-11, 1993, **TARGET Environmental Services, Inc. (TARGET)** conducted a site screening survey at **NAB Little Creek**, Virginia Beach, Virginia. Under the direction of **Foster Wheeler Environmental Services**, a total of 32 soil gas samples were collected in the area of Building 3651 (former musical instrument plating facility) and 18 ground water samples were collected in the area of the Commissary Store (former laundromat/dry cleaners). The sampling locations are shown on the accompanying copies of the field maps. Soil gas Samples 206 and 222 were collected at a depth of 2 feet due to probe refusal. All of the remaining soil gas samples were collected at the planned 4 foot depth. The ground water sampling depths varied from 9 to 14 feet and are reported in Table 3.

To collect the **soil gas** samples a 1/2 inch hole was produced to a depth of approximately 4 feet by using a drive rod. Where pavement was present, a rotary hammer was employed for penetration prior to using the drive rod. The entire sampling system was purged with ambient air drawn through an organic vapor filter cartridge, and a stainless steel probe was inserted to the full depth of the hole and sealed off from the atmosphere. A sample of in-situ soil gas was then withdrawn through the probe and used to purge atmospheric air from the sampling system. A second sample of soil gas was withdrawn through the probe and encapsulated in a pre-evacuated glass vial at two atmospheres of pressure (15 psig). The self-sealing vial was detached from the sampling system, packaged, labeled, and stored for laboratory analysis. All sampling holes were backfilled with bentonite and the surface repaired with like material upon completion of the sampling.

Prior to the day's field activities all soil gas sampling equipment, slide hammer rods and probes were decontaminated by washing with soapy water and rinsing thoroughly. Internal

surfaces were flushed dry using pre-purified nitrogen or filtered ambient air, and external surfaces were wiped clean using clean paper towels.

To collect the **ground water** samples a van-mounted hydraulic probe was used to advance connected 3 foot sections of 1" diameter threaded steel casing to the sampling depth. An electric hammer drill was used to penetrate pavement where necessary. Once the steel casing was in place, water was allowed to fill the pipe. A teflon sampling tube was placed down the pipe and ground water was collected from just below the water surface using a peristaltic or a manual syringe pump. Samples were placed in bottles and acidified to pH 2 using a 50% hydrochloric acid-water mixture, sealed, labeled and shipped on ice to the laboratory.

Prior to the day's field activities and after collection of each ground water sample, the steel casing and teflon sampling tube were decontaminated by washing with a solution of Alconox (a biodegradable, laboratory grade detergent), rinsing with distilled water and drying with nitrogen gas or filtered ambient air.

The initial soil gas samples and the headspaces of the initial ground water samples were screened on-site with a portable Photovac gas chromatograph equipped with a photoionization detector (PID) in order to guide the placement of subsequent sampling locations. The results of the in-field PID screening (PID totals only) are reported in micrograms per liter (μg/l) in Tables 1 and 3.

All of the soil gas samples and the headspaces of the ground water samples collected during the field phase of the survey were subjected to dual analyses at **TARGET**'s "home" laboratory in Columbia, Maryland. One analysis was conducted according to EPA Method 601 (modified) on a gas chromatograph equipped with an electron capture detector (ECD), and using direct injection. Specific analytes standardized for this analysis were:

1,1-dichloroethene (11DCE)
methylene chloride (CH_2Cl_2)
trans-1,2-dichloroethene (t12DCE)
1,1-dichloroethane (11DCA)
cis-1,2-dichloroethene (c12DCE)
chloroform ($CHCl_3$)
1,1,1-trichloroethane (111TCA)
carbon tetrachloride (CCl_4)
trichloroethene (TCE)
1,1,2-trichloroethane (112TCA)
tetrachloroethene (PCE)

The chlorinated hydrocarbons in this suite were chosen because of their common usage in industrial solvents, and/or their degradational relationship to commonly used compounds.

The second analysis was conducted according to EPA Method 602 (modified) on a gas chromatograph equipped with a flame ionization detector (FID), and using direct injection. The analytes selected for standardization in this analysis were:

benzene
toluene
ethylbenzene
meta- and para- xylene
ortho- xylene

These compounds were chosen because of their utility in evaluating the presence of fuel products, or petroleum based solvents.

The analytical equipment was calibrated using a 3-point instrument-response curve and injection of known concentrations of the target analytes. Retention times of the standards were used to identify the peaks in the chromatograms of the field samples, and their response factors were used to calculate the analyte concentrations. The **ground water** samples were prepared for analysis by pouring 15 ml of sample into a 30 ml EPA clean vial and sealing with a teflon-faced butyl rubber septum. The vial was heated for 10 minutes to volatilize hydrocarbons from the water. The headspace of the sample was then directly injected into the gas chromatograph.

The tabulated results of the laboratory analyses of the soil gas samples and the headspaces of the ground water samples are reported in micrograms per liter (µg/l) in Tables 1 through 4. Although "micrograms per liter" is equivalent to "parts per billion (v/v)" in water analyses, they are not equivalent in gas analyses, due to the difference in the mass of equal volumes of water and gas matrices. The xylenes concentrations reported in Tables 1 and 3 are the sum of the m- and p-xylene and the o-xylene concentrations for each sample.

Total FID Volatiles values were generated by summing the areas of all integrated chromatogram peaks and calculated using the instrument response factor for toluene. Injection peaks, which also contain the light hydrocarbon methane, were excluded to avoid the skewing of Total FID Volatiles values due to injection disturbances and biogenic methane. For samples with low hydrocarbon concentrations, the calculated Total FID Volatiles concentration is occasionally lower than the sum of the individual analytes. This is because the response factor used for the Total FID Volatiles calculation is a constant, whereas the individual analyte response factors are compound specific. It is important to understand that the Total FID Volatiles levels reported are relative, not absolute, values.

Quality Assurance/Quality Control (QA/QC) Evaluation

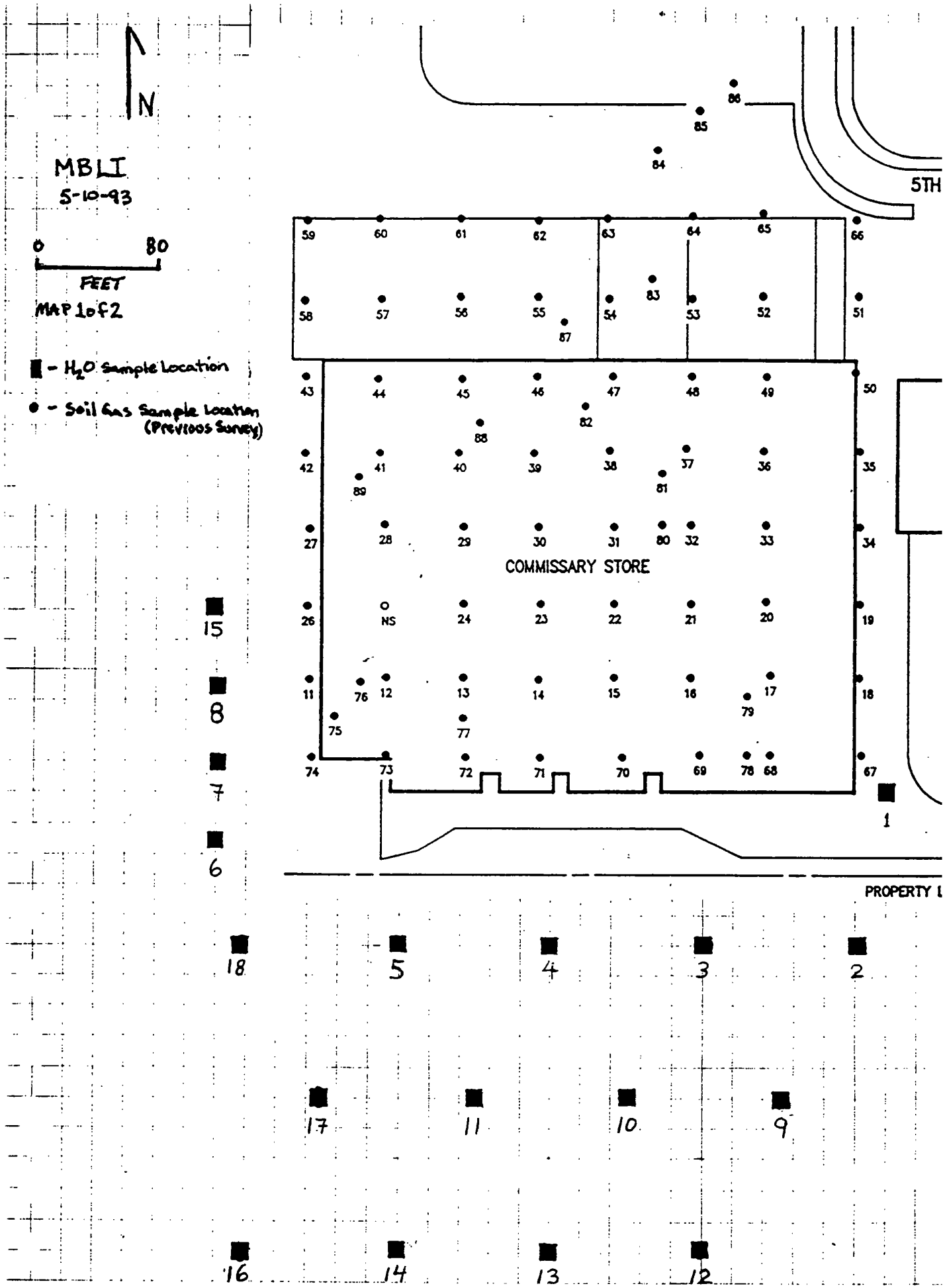
Field QA/QC Samples

Soil gas field control samples were collected at the beginning and end of the day's field activities and after every twentieth soil gas sample. These QA/QC samples were obtained by filtering ambient air through a dust and organic vapor filter cartridge and encapsulating as described above. The laboratory results of the analysis of these samples are reported in Tables 1 and 2. Concentrations of all analytes were below the reporting limit in all field control samples.

Equipment rinseate samples were collected at the beginning and end of each day's ground water sampling activities. These QA/QC samples were obtained by collecting bottled distilled water through the teflon sampling tube. The laboratory results of the analysis of these samples are reported in Tables 3 and 4. Concentrations of all analytes were below the reporting limit in all rinseate samples.

Laboratory QA/QC Samples

A duplicate analysis was performed on every tenth soil gas sample. A duplicate headspace sample was prepared and analyzed for every tenth ground water sample. Laboratory blanks of nitrogen gas were also analyzed after every tenth field sample. The results of these analyses are reported in Tables 1 through 4. All duplicate analyses were within acceptable limits. Concentrations of all analytes were below the reporting limit in all laboratory blanks.


N
MBLI
5-10-93
0
80
FEET
MAP 1 of 2
■ - H_2O Sample Location
● - Soil Gas Sample Location (Previous Survey)
5TH
COMMISSARY STORE
PROPERTY L
NS
1
2
3
4
5
6
7
8
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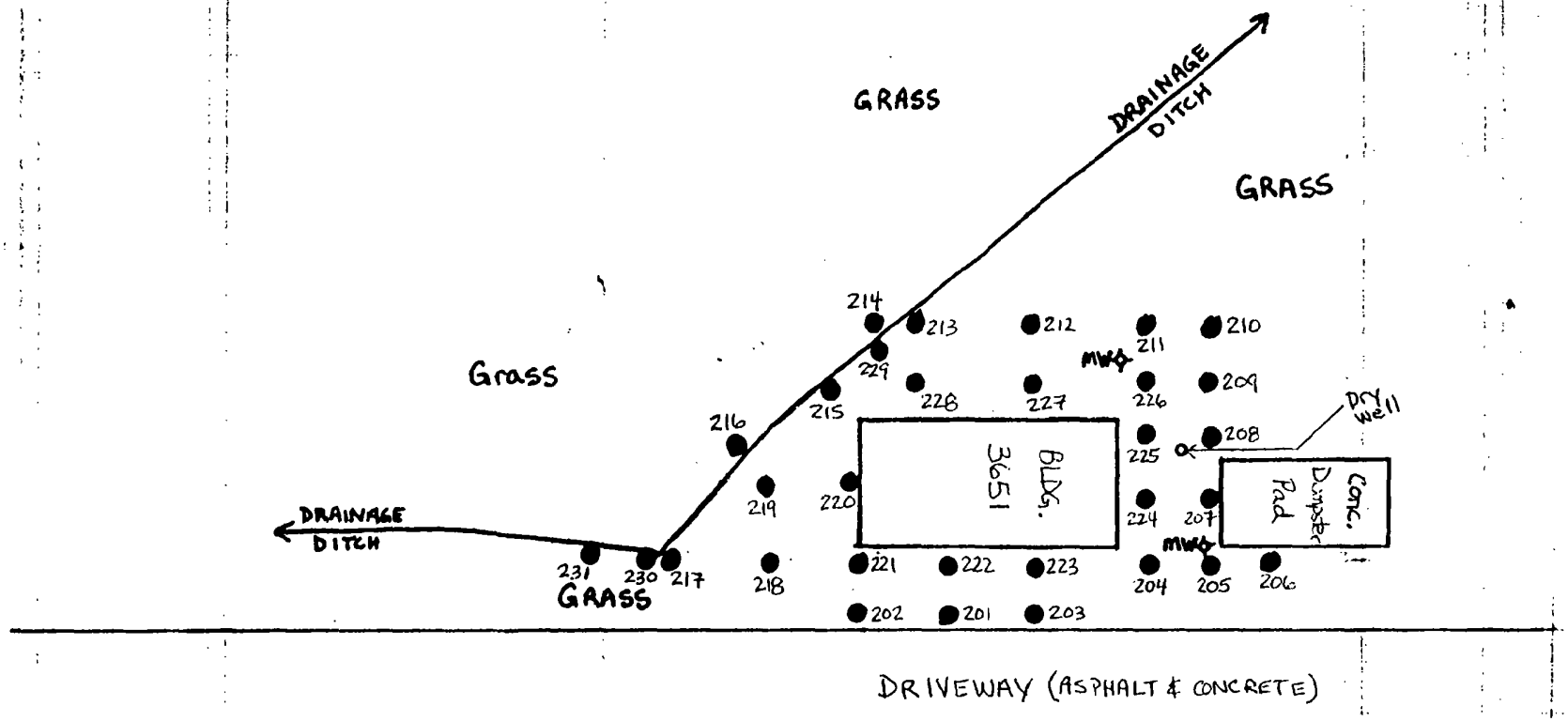
18

MBLI 5-10-93
map 2 of 2



● Soil Gas Sample Loca

TABLE 1

ANALYTE CONCENTRATIONS IN SOIL GAS VIA GC/FID (µg/l)

SAMPLE	IN-FIELD TOTAL PID	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID VOLATILES*
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	10
201	<10	<1.0	<1.0	<1.0	<1.0	<10
202	<10	<1.0	<1.0	<1.0	<1.0	<10
203	<10	<1.0	<1.0	<1.0	<1.0	<10
204	<10	<1.0	<1.0	<1.0	<1.0	<10
205	<10	<1.0	<1.0	<1.0	<1.0	<10
206	<10	<1.0	<1.0	<1.0	<1.0	<10
207	<10	<1.0	<1.0	<1.0	<1.0	<10
208	<10	<1.0	<1.0	<1.0	<1.0	<10
209	<10	<1.0	<1.0	<1.0	<1.0	<10
210	<10	<1.0	<1.0	<1.0	<1.0	<10
211	<10	<1.0	<1.0	<1.0	<1.0	<10
212	<10	<1.0	<1.0	<1.0	<1.0	<10
213	<10	<1.0	<1.0	<1.0	<1.0	<10
214	<10	<1.0	<1.0	<1.0	<1.0	<10
215	<10	<1.0	<1.0	<1.0	<1.0	<10
216	<10	<1.0	<1.0	<1.0	<1.0	<10
217	<10	<1.0	<1.0	<1.0	<1.0	<10
218	<10	<1.0	<1.0	<1.0	<1.0	<10
219	<10	<1.0	<1.0	<1.0	<1.0	<10
220	<10	<1.0	<1.0	<1.0	<1.0	<10
221	N/A	<1.0	<1.0	<1.0	<1.0	<10
222	N/A	<1.0	<1.0	<1.0	<1.0	<10
223	N/A	<1.0	<1.0	<1.0	<1.0	<10
224	N/A	<1.0	<1.0	<1.0	<1.0	<10
225	N/A	<1.0	<1.0	<1.0	<1.0	<10
226	N/A	<1.0	<1.0	<1.0	<1.0	<10
227	N/A	<1.0	<1.0	<1.0	<1.0	<10
228	N/A	<1.0	<1.0	<1.0	<1.0	<10
229	N/A	<1.0	<1.0	<1.0	<1.0	<10
230	N/A	<1.0	<1.0	<1.0	<1.0	<10
231	N/A	<1.0	<1.0	<1.0	<1.0	<10
232	N/A	<1.0	<1.0	<1.0	<1.0	<10

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE*

TABLE 1 (CONT.)

ANALYTE CONCENTRATIONS IN SOIL GAS VIA GC/FID (µg/l)

SAMPLE	IN-FIELD TOTAL PID	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID VOLATILES*
REPORTING LIMIT	10	1.0	1.0	1.0	1.0	10
FIELD CONTROL SAMPLES						
301	<10	<1.0	<1.0	<1.0	<1.0	<10
302	<10	<1.0	<1.0	<1.0	<1.0	<10
303	N/A	<1.0	<1.0	<1.0	<1.0	<10
304	N/A	<1.0	<1.0	<1.0	<1.0	<10
LABORATORY DUPLICATE ANALYSIS						
210	<10	<1.0	<1.0	<1.0	<1.0	<10
210R	<10	<1.0	<1.0	<1.0	<1.0	<10
220	<10	<1.0	<1.0	<1.0	<1.0	<10
220R	<10	<1.0	<1.0	<1.0	<1.0	<10
230	N/A	<1.0	<1.0	<1.0	<1.0	<10
230R	N/A	<1.0	<1.0	<1.0	<1.0	<10
LABORATORY BLANKS						
210B	<10	<1.0	<1.0	<1.0	<1.0	<10
220B	<10	<1.0	<1.0	<1.0	<1.0	<10
230B	N/A	<1.0	<1.0	<1.0	<1.0	<10

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE*

TABLE 2

ANALYTE CONCENTRATIONS IN SOIL GAS VIA GC/ECD (µg/l)

SAMPLE	11DCE	CH2CL2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCL4	TCE	112TCA
REPORTING LIMIT	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
201	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
202	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
203	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
204	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
205	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
206	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
207	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
208	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
209	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
210	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
211	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
212	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
213	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
214	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
215	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
216	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
217	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
218	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
219	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
220	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
221	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
222	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
223	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
224	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
225	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
226	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
227	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
228	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
229	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
230	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
231	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
232	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
11DCA = 1,1-dichloroethane
111TCA = 1,1,1-trichloroethane
112TCA = 1,1,2-trichloroethane
CH2CL2 = methylene chloride
c12DCE = cis-1,2-dichloroethene
CCl4 = carbon tetrachloride
PCE = tetrachloroethene
t12DCE = trans-1,2-dichloroethene
CHCl3 = chlororform
TCE = trichloroethene

TABLE 2 (CONT.)

ANALYTE CONCENTRATIONS IN SOIL GAS VIA GC/ECD (µg/l)

SAMPLE	11DCE	CH2CL2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCL4	TCE	112TCA
REPORTING LIMIT	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
FIELD CONTROL SAMPLES										
301	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
302	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
303	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
304	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
LABORATORY DUPLICATE ANALYSIS										
210	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
210R	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
220	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
220R	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
230	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
230R	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
LABORATORY BLANKS										
210B	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
220B	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
230B	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
11DCA = 1,1-dichloroethane
111TCA = 1,1,1-trichloroethane
112TCA = 1,1,2-trichloroethane
CH2CL2 = methylene chloride
c12DCE = cis-1,2-dichloroethene
CCl4 = carbon tetrachloride
PCE = tetrachloroethene
t12DCE = trans-1,2-dichloroethene
CHCl3 = chlororform
TCE = trichloroethene

TABLE 3

ANALYTE CONCENTRATIONS IN HEADSPACE OF GROUND WATER
VIA GC/FID (µg/l OF AIR)

SAMPLE	DEPTH (FT)	IN-FIELD TOTAL PID	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID VOLATILES*
REPORTING LIMIT		10	1.0	1.0	1.0	1.0	10
1	14	<10	<1.0	<1.0	<1.0	<1.0	<10
2	14	<10	<1.0	<1.0	<1.0	<1.0	<10
3	14	25	<1.0	<1.0	<1.0	<1.0	38
4	14	220	<1.0	<1.0	<1.0	<1.0	365
5	9	240	<1.0	<1.0	<1.0	<1.0	461
6	14	35	<1.0	<1.0	<1.0	<1.0	37
7	14	20	<1.0	<1.0	<1.0	<1.0	18
8	10	12	<1.0	<1.0	<1.0	<1.0	14
9	10	<10	<1.0	<1.0	<1.0	<1.0	<10
10	10	17	<1.0	<1.0	<1.0	<1.0	25
11	9.5	N/A	<1.0	<1.0	<1.0	14	11,200
12	10	N/A	<1.0	<1.0	<1.0	<1.0	<10
13	10	N/A	<1.0	<1.0	<1.0	<1.0	<10
14	10	N/A	<1.0	<1.0	<1.0	<1.0	<10
15	10	N/A	<1.0	<1.0	<1.0	<1.0	<10
16	10	N/A	<1.0	<1.0	<1.0	<1.0	<10
17	10	N/A	<1.0	<1.0	<1.0	<1.0	12
18	10	N/A	<1.0	<1.0	<1.0	<1.0	25
EQUIPMENT RINSEATE SAMPLES							
101	N/A	<10	<1.0	<1.0	<1.0	<1.0	<10
102	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<10
103	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<10
104	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<10
ANALYSIS OF DUPLICATE SAMPLES							
12	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<10
12D	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<10
4	N/A	N/A	<1.0	<1.0	<1.0	<1.0	365
4D	N/A	N/A	<1.0	<1.0	<1.0	<1.0	395

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE*

TABLE 3 (CONT.)

ANALYTE CONCENTRATIONS IN HEADSPACE OF GROUND WATER
VIA GC/FID (µg/l OF AIR)

SAMPLE	DEPTH (FT)	IN-FIELD TOTAL PID	BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES	TOTAL FID VOLATILES*
REPORTING LIMIT		10	1.0	1.0	1.0	1.0	10
LABORATORY BLANKS							
12B	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<10
4B	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<10

** CALCULATED USING THE SUM OF THE AREAS OF ALL INTEGRATED CHROMATOGRAM PEAKS AND THE INSTRUMENT RESPONSE FACTOR FOR TOLUENE*

TABLE 4

ANALYTE CONCENTRATIONS IN HEADSPACE OF GROUND WATER VIA GC/ECD (µg/l OF AIR)

SAMPLE	11DCE	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4	TCE	112TCA	P
REPORTING LIMIT	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
1	<1.0	<1.0	<1.0	<1.0	2.9	1.5	<1.0	<1.0	<1.0	<1.0	<
2	<1.0	<1.0	<1.0	<1.0	7.4	<1.0	<1.0	<1.0	<1.0	<1.0	<
3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1
4	<1.0	<1.0	<1.0	<1.0	11	<1.0	<1.0	<1.0	1.7	<1.0	1,8
5	<1.0	<1.0	<1.0	<1.0	2.7	<1.0	<1.0	<1.0	6.8	<1.0	2,2
6	<1.0	<1.0	<1.0	<1.0	6.4	<1.0	<1.0	<1.0	6.6	<1.0	1
7	<1.0	<1.0	<1.0	<1.0	7.3	<1.0	<1.0	<1.0	4.0	<1.0	
8	<1.0	<1.0	<1.0	<1.0	7.8	<1.0	<1.0	<1.0	5.5	<1.0	
9	<1.0	<1.0	<1.0	<1.0	3.2	<1.0	<1.0	<1.0	<1.0	<1.0	<
10	<1.0	<1.0	<1.0	<1.0	2.6	<1.0	<1.0	<1.0	<1.0	<1.0	
11	61	<1.0	351	<1.0	51,560	<1.0	<1.0	<1.0	973	3.5	13,
12	<1.0	<1.0	<1.0	<1.0	8.5	1.2	<1.0	<1.0	<1.0	<1.0	
13	<1.0	<1.0	<1.0	<1.0	9.6	<1.0	<1.0	<1.0	<1.0	<1.0	
14	<1.0	<1.0	<1.0	<1.0	4.9	<1.0	<1.0	<1.0	<1.0	<1.0	
15	<1.0	<1.0	<1.0	<1.0	6.6	<1.0	<1.0	<1.0	2.9	<1.0	
16	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<
17	<1.0	<1.0	<1.0	<1.0	4.5	<1.0	<1.0	<1.0	<1.0	<1.0	
18	<1.0	<1.0	<1.0	<1.0	15	<1.0	<1.0	<1.0	4.8	<1.0	
EQUIPMENT RINSEATE SAMPLES											
101	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
102	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
103	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
104	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
ANALYSIS OF DUPLICATE SAMPLES											
12	<1.0	<1.0	<1.0	<1.0	8.5	1.2	<1.0	<1.0	<1.0	<1.0	
12D	<1.0	<1.0	<1.0	<1.0	8.9	1.3	<1.0	<1.0	<1.0	<1.0	
4	<1.0	<1.0	<1.0	<1.0	11	<1.0	<1.0	<1.0	1.7	<1.0	1
4D	<1.0	<1.0	<1.0	<1.0	12	<1.0	<1.0	<1.0	1.8	<1.0	1

11DCE = 1,1-dichloroethene
11DCA = 1,1-dichloroethane
111TCA = 1,1,1-trichloroethane
112TCA = 1,1,2-trichloroethane
CH2Cl2 = methylene chloride
c12DCE = cis-1,2-dichloroethene
CCl4 = carbon tetrachloride
PCE = tetrachloroethene
t12DCE = trans-1,2-dichloroethene
CHCl3 = chlororform
TCE = trichloroethene

TABLE 4 (CONT.)

ANALYTE CONCENTRATIONS IN HEADSPACE OF GROUND WATER VIA GC/ECD (µg/l OF AIR)

SAMPLE	11DCE	CH2Cl2	t12DCE	11DCA	c12DCE	CHCl3	111TCA	CCl4	TCE	112TCA
REPORTING LIMIT	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
LABORATORY BLANKS										
12B	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
4B	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

11DCE = 1,1-dichloroethene
11DCA = 1,1-dichloroethane
111TCA = 1,1,1-trichloroethane
112TCA = 1,1,2-trichloroethane
CH2Cl2 = methylene chloride
c12DCE = cis-1,2-dichloroethene
CCl4 = carbon tetrachloride
PCE = tetrachloroethene
t12DCE = trans-1,2-dichloroethene
CHCl3 = chloroform
TCE = trichloroethene

APPENDIX J

Data Validation Report
(Included under separate cover as Volume III.)

APPENDIX K

Risk-Based Concentration Tables

EPA REGION III RISK–BASED CONCENTRATIONS
TCL VOLATILE COMPOUNDS
JANUARY 7, 1994

COMPOUND	TAP WATER (µg/l)	AMBIENT AIR (µg/m³)	FISH (mg/kg)	COMMERCIAL/ INDUSTRIAL SOIL (mg/kg)	RESIDENTIAL SOIL (mg/kg)
Chloromethane	1.4	0.99	0.24	220	49
Bromomethane	8.7	5.2	1.9	1400	110
Vinyl Chloride	0.019	0.021	0.0017	1.5	0.34
Chloroethane	710	10000	27	20000	1600
Methylene Chloride	4.1	3.8	0.42	380	85
Acetone	3700	370	140	100000	7800
Carbon disulfide	21	10	140	100000	7800
1,1–Dichloroethene	0.44	0.036	0.0053	4.8	1.1
1,1–Dichloroethane	810	520	140	100000	7800
1,2–Dichloroethene (total)	55	33	12	9200	700
Chloroform	0.15	0.078	0.52	470	100
1,2–Dichloroethane	0.12	0.069	0.035	31	7
2–Butanone	22000	1000	810	610000	47000
1,1,1–Trichloroethane	1300	1000	120	92000	7000
Carbon Tetrachloride	0.16	0.12	0.024	22	4.9
Bromodichloromethane	0.17	0.1	0.051	46	10
1,2–Dichloropropane	0.16	0.092	0.046	42	9.4
cis–1,3–Dichloropropene	0.077	0.048	0.018	16	3.5
Trichloroethene	1.6	1	0.29	260	58
Dibromochloromethane	0.13	0.075	0.038	34	7.6
1,1,2–Trichloroethane	0.19	0.11	0.055	50	11
Benzene	0.36	0.22	0.11	99	22
trans–1,3–Dichloropropene	0.077	0.048	0.018	16	3.5
Bromoform	2.4	1.6	0.4	360	81
4–Methyl–2–pentanone	1800	84	68	51000	3900
2–Hexanone *	–	–	–	–	–
Tetrachloroethene	1.1	3.1	0.061	55	12
Toluene	750	420	270	200000	16000
1,1,2,2–Tetrachloroethane	0.052	0.031	0.016	14	3.2
Chlorobenzene	39	21	27	20000	1600
Ethyl Benzene	1300	1000	140	100000	7800
Styrene	1600	1000	270	200000	16000
Xylenes (total)	12000	7300	2700	1000000	160000

Notes:
1) TCL indicates Target Compound List.
2) * indicates compound not located on EPA Region III Risk–Based Concentrations list.

Source:
January 7, 1994 update of EPA Region III Risk–Based Concentrations (for use with Region III technical guidance on selecting exposure routes and contaminants of concern by risk–based screening) originally included as Appendix I of "Selecting Exposure Routes and Contaminants of Concern by Risk–Based Screening." Region III Technical Guidance Manual, Risk Assessment, January, 1993. (EPA/903/R–93–001)

EPA REGION III RISK-BASED CONCENTRATIONS
TCL SEMI-VOLITILE COMPOUNDS
JANUARY 7, 1994

COMPOUND	TAP WATER (µg/l)	AMBIENT AIR (µg/m³)	FISH (mg/kg)	COMMERCIAL/ INDUSTRIAL SOIL (mg/kg)	RESIDENTIAL SOIL (mg/kg)
Phenol	22000	2200	810	610000	47000
bis(2-Chloroethyl) ether	0.0092	0.0054	0.0029	2.6	0.58
2-Chlorophenol	180	18	6.8	5100	390
1,3-Dichlorobenzene	540	320	120	91000	7000
1,4-Dichlorobenzene	0.44	0.26	0.13	120	27
1,2-Dichlorobenzene	370	210	120	92000	7000
2-Methylphenol	1800	180	68	51000	3900
2,2'-oxybis (1-Chloropropane) *	–	–	–	–	–
4-Methylphenol	180	18	6.8	5100	390
N-Nitroso-di-n-propylamine	0.0096	0.00069	0.00045	0.41	0.091
Hexachloroethane	0.75	0.45	0.23	200	46
Nitrobenzene	3.4	2.1	0.68	510	39
Isophorone	71	6.6	3.3	3000	670
2-Nitrophenol *	–	–	–	–	–
2,4-Dimethylphenol	730	73	27	20000	1600
bis(2-Chloroethoxy) methane *	–	–	–	–	–
2,4-Dichlorophenol	110	11	4.1	3100	230
1,2,4-Trichlorobenzene	18	9.4	14	10000	780
Naphthalene	1500	150	54	41000	3100
4-Chloroaniline	150	15	5.4	4100	310
Hexachlorobutadiene	0.14	0.081	0.04	37	8.2
4-Chloro-3-methylphenol *	–	–	–	–	–
2-Methylnaphthalene *	–	–	–	–	–
Hexachlorocyclopentadiene	0.15	0.073	9.5	7200	550
2,4,6-Trichlorophenol	6.1	0.57	0.29	260	58
2,4,5-Trichlorophenol	3700	370	140	100000	7800
2-Chloronaphthalene	2900	290	110	82000	6300
2-Nitroaniline	2.2	0.21	0.081	61	4.7
Dimethylphthalate	370000	37000	14000	1000000	780000
Acenaphthylene *	–	–	–	–	–
2,6-Dinitrotoluene *	37	3.7	1.4	1000	78
3-Nitroaniline	110	11	4.1	3100	230
Acenaphthene	2200	220	81	61000	4700
2,4-Dinitrophenol	73	7.3	2.7	2000	160
4-Nitrophenol	2300	230	84	63000	4800
Dibenzofuran *	–	–	–	–	–
2,4-Dinitrotoluene	73	7.3	2.7	2000	160
Diethylphthalate	29000	2900	1100	820000	63000
4-Chlorophenyl-phenyl ether *	–	–	–	–	–
Fluorene	1500	150	54	41000	3100
4-Nitroaniline	110	11	4.1	3100	230
4,6-Dinitro-2-methylphenol *	–	–	–	–	–
N-nitrosodiphenylamine	14	1.3	0.64	580	130
4-Bromophenyl-phenylether	2100	210	78	59000	4500
Hexachlorobenzene	0.0066	0.0039	0.002	1.8	0.4
Pentachlorophenol	0.56	0.052	0.026	24	5.3
Phenanthrene *	–	–	–	–	–
Anthracene	11000	1100	410	310000	23000
Carbazole	3.4	0.31	0.16	140	32
Di-n-butylphthalate	3700	370	140	100000	7800
Fluoranthene	1500	150	54	41000	3100
Pyrene	1100	110	41	31000	2300
Butylbenzylphthalate	7300	730	270	200000	16000
3,3'-Dichlorobenzidine	0.15	0.014	0.007	6.4	1.4
Benzo(a)anthracene	0.092	0.01	0.0043	3.9	0.88
Chrysene	9.2	1	0.43	390	88
bis(2-Ethylhexyl)phthalate	4.8	0.45	0.23	200	46
Di-n-octylphthalate	730	73	27	20000	1600
Benzo(b)fluoranthene	0.092	0.01	0.0043	3.9	0.88
Benzo(k)fluoranthene	0.92	0.1	0.043	39	8.8
Benzo(a)pyrene	0.0092	0.001	0.00043	0.39	0.088
Indeno(1,2,3-cd)pyrene	0.092	0.01	0.0043	3.9	0.88
Dibenzo(a,h)anthracene	0.0092	0.001	0.00043	0.39	0.088
Benzo(ghi)perylene *	–	–	–	–	–

Notes:
1) TCL indicates Target Compound List.
2) * indicates compound not located on EPA Region III Risk-Based Concentrations list.

Source:
January 7, 1994 update of EPA Region III Risk-Based Concentrations (for use with Region III technical guidance on selecting exposure routes and contaminants of concern by risk-based screening) originally included as Appendix I of "Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening," Region III Technical Guidance Manual, Risk Assessment, January, 1993. (EPA/903/R-93-001)

EPA REGION III RISK–BASED CONCENTRATIONS
TCL PESTICIDES AND PCBs
JANUARY 7, 1994

COMPOUND	TAP WATER (µg/l)	AMBIENT AIR (µg/m³)	FISH (mg/kg)	COMMERCIAL/ INDUSTRIAL SOIL (mg/kg)	RESIDENTIAL SOIL (mg/kg)
alpha–BHC	0.011	0.00099	0.0005	0.45	0.10
beta–BHC	0.037	0.0035	0.0018	1.6	0.35
delta–BHC *	–	–	–	–	–
gamma–BHC (Lindane)	0.052	0.0048	0.0024	2.2	0.49
Heptachlor	0.0023	0.0014	0.0007	0.64	0.14
Aldrin	0.004	0.00037	0.00019	0.17	0.038
Heptachlor epoxide	0.0012	0.00069	0.00035	0.31	0.07
Endosulfan	220	22	8.1	6100	470
Dieldrin	0.0042	0.00039	0.0002	0.18	0.04
4,4'–DDE	0.2	0.18	0.0093	8.4	1.9
Endrin	11	1.1	0.41	310	23
4,4'–DDD	0.28	0.026	0.013	12	2.7
Endosulfan sulfate *	–	–	–	–	–
4,4'–DDT	0.2	0.018	0.0093	8.4	1.9
Methoxychlor	180	18	6.8	5100	390
Endrin ketone *	–	–	–	–	–
Endrin Aldehyde *	–	–	–	–	–
Chlordane	0.052	0.0049	0.0024	2.2	0.49
Toxaphene	0.061	0.0056	0.0029	2.6	0.58
PCBs	0.0087	0.00081	0.00041	0.37	0.083
Aroclor 1016	2.6	0.26	0.095	72	5.5

Notes:
1) TCL indicates Target Compound List.
2) PCBs indicates polychlorinated biphenyls
3) * indicates compound not located on EPA Region III Risk–Based Concentration list.

Source:
January 7, 1994 update of EPA Region III Risk–Based Concentrations (for use with Region III technical guidance on selecting exposure routes and contaminants of concern by risk–based screening) originally included as Appendix I of "Selecting Exposure Routes and Contaminants of Concern by Risk–Based Screening," Region III Technical Guidance Manual, Risk Assessment, January, 1993. (EPA/903/R–93–001)

EPA REGION III RISK–BASED CONCENTRATIONS
INORGANIC TARGET ANALYTE LIST
JANUARY 7, 1994

COMPOUND	TAP WATER (µg/l)	AMBIENT AIR (µg/m³)	FISH (mg/kg)	COMMERCIAL/ INDUSTRIAL SOIL (mg/kg)	RESIDENTIAL SOIL (mg/kg)
Aluminum	110000	11000	3900	1000000	230000
Antimony	15	1.5	0.54	410	31
Arsenic	11	1.1	0.41	310	23
Arsenic (as arsine)	0.038	0.00041	0.0018	1.6	0.37
Barium	2600	0.52	95	72000	5500
Beryllium	0.016	0.00075	0.00073	0.67	0.15
Cadmium	18	0.00099	0.68	510	39
Calcium *	–	–	–	–	–
Chromium III	37000	0.0021	1400	1000000	78000
Chromium VI	180	0.00015	6.8	5100	390
Cobalt *	–	–	–	–	–
Copper	1400	140	50	38000	2900
Iron *	–	–	–	–	–
Lead (tetraethyl)	0.0037	0.00037	0.00014	0.1	0.0078
Magnesium *	–	–	–	–	–
Manganese	180	0.052	6.8	5100	390
Mercury (methyl)	11	1.1	0.41	310	23
Mercury (inorganic)	11	0.31	0.41	310	23
Nickel	730	73	27	20000	1600
Potassium *	–	–	–	–	–
Selenium	180	18	6.8	5100	390
Silver	180	18	6.8	5100	390
Sodium *	–	–	–	–	–
Thallium *	–	–	–	–	–
Vanadium	260	26	9.5	7200	550
Cyanide (free)	730	73	27	20000	1600

Note:
1) * indicates compound not located on EPA Region III Risk–Based Concentrations list.

Source:
January 7, 1994 update of EPA Region III Risk–Based Concentrations (for use with Region III technical guidance on selecting exposure routes and contaminants of concern by risk–based screening) originally included as Appendix I of "Selecting Exposure Routes and Contaminants of Concern by Risk–Based Screening," Region III Technical Guidance Manual, Risk Assessment, January, 1993. (EPA/903/R–93–001)

APPENDIX L

EPA and VA Water Quality Standards

DRINKING WATER REGULATIONS

AND HEALTH ADVISORIES

by

Office of Water
U.S. Environmental Protection Agency
Washington, D.C.
202-260-7571

SAFE DRINKING WATER HOTLINE
1-800-426-4791
Monday thru Friday, 8:30 AM to 5:00 PM EST

May 1993

LEGEND

Abbreviations column descriptions are:

MCLG - Maximum Contaminant Level Goal. A non-enforceable concentration of a drinking water contaminant that is protective of adverse human health effects and allows an adequate margin of safety.

MCL - Maximum Contaminant Level. Maximum permissible level of a contaminant in water which is delivered to any user of a public water system.

RfD - Reference Dose. An estimate of a daily exposure to the human population that is likely to be without appreciable risk of deleterious effects over a lifetime.

DWEL - Drinking Water Equivalent Level. A lifetime exposure concentration protective of adverse, non-cancer health effects, that assumes all of the exposure to a contaminant is from a drinking water source.

(*) The codes for the Status Reg and Status HA columns are as follows:

F - final
D - draft
L - listed for regulation
P - proposed
T - tentative

Other codes found in the table include the following:

NA - not applicable
PS - performance standard 0.5 NTU - 1.0 NTU
TT - treatment technique

** - No more than 5% of the samples per month may be positive. For systems collecting fewer than 40 samples/month, no more than 1 sample per month may be positive.

*** - guidance

- Large discrepancies between Lifetime and Longer-term HA values may occur because of the Agency's conservative policies, especially with regard to carcinogenicity, relative source contribution, and less than lifetime exposures in chronic toxicity testing. These factors can result in a cumulative UF (uncertainty factor) of 10 to 1000 when calculating a Lifetime HA.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
ORGANICS													
Acenaphthene	-	-	-	-	-	-	-	-	0.06	-	-	-	-
Acifluorfen	T	zero	-	F	2	2	0.1	0.4	0.013	0.4	-	0.1	B2
Acrylamide	F	zero	TT	F	1.5	0.3	0.02	0.07	0.0002	0.007	-	0.001	B2
Acrylonitrile	T	zero	-	D	-	-	-	-	-	-	-	0.006	B1*
Adipates (diethylhexyl)	P	0.5	0.5	-		-	-	-	0.7	20	0.5		C
Alachlor	F	zero	0.002	F	0.1	0.1	-	-	0.01	0.4	-	0.04	B2
Aldicarb	F	0.001	0.003	F	-	-	-	-	*0.001*	*0.035*	*0.007*	-	D
Aldicarb sulfone	F	0.001	0.002	F	-	-	-	-	*0.001*	*0.035*	*0.007*		D
Aldicarb sulfoxide	F	0.001	0.004	F	-	-	-	-	*0.001*	*0.035*	*0.007*		D
Aldrin	-	-	-	D	0.0003	0.0003	0.0003	0.0003	0.00003	0.001	-	0.0002	B2
Ametryn	-	-	-	F	9	9	0.9	3	0.009	0.3	0.06	-	D
Ammonium sulfamate	-	-	-	F	20	20	20	80	0.28	8	2	-	D
Anthracene (PAH)	-	-	-	-	-	-	-	-	0.3	-	-	-	D
Atrazine	F	0.003	0.003	F	0.1	0.1	0.05	0.2	*0.035*	0.2*	0.003*	-	C
Baygon	-	-	-	F	0.04	0.04	0.04	0.1	0.004	0.1	0.003	-	C
Bentazon	T	*0.02*	-	F	0.3	0.3	0.3	0.9	0.0025	0.09	0.02	-	D
Benz(a)anthracene (PAH)	P	zero	0.0001	-	-	-	-	-	-	-	-	-	B2
Benzene	F	zero	0.005	F	0.2	0.2	-	-	-	-	-	0.1	A
Benzo(a)pyrene (PAH)	F	zero	0.0002	-	-	-	-	-	-	-	-		B2*
Benzo(b)fluoranthene (PAH)	P	zero	0.0002	-	-	-	-	-	-	-	-		B2
Benzo(g,h,i)perylene (PAH)	-	-	-	-	-	-	-	-	-	-	-		D
Benzo(k)fluoranthene (PAH)	P	zero	0.0002	-	-	-	-	-	-	-	-	-	B2
bis-2-Chloroisopropyl ether	-	-	-	F	4	4	4	13	0.04	1	0.3		D
Bromacil	L	-	-	F	5	5	3	9	0.13	5	0.09	-	C
Bromobenzene	L		-	D	-	-	-	-	-	-	-		

* Under review

[illegible] not monitored in Phase V.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Bromochloroacetonitrile	L	-	-	D	-	-	-	-	-	-	-	-	-
Bromochloromethane	-	-	-	F	50	1	1	5	0.013	0.5	0.09	-	-
Bromodichloromethane (THM)	T	zero	0.1*	D	7	7	4	13	0.02	0.7	-	0.06	B2
Bromoform (THM)	T	zero	0.1*	D	5	2	2	6	0.02	0.7	-	0.4	B2
Bromomethane	T	-	-	F	0.1	0.1	0.1	0.5	0.001	0.04	0.01	-	D
Butyl benzyl phthalate (PAE)	P	zero	0.1	-	-	-	-	-	0.2	6	-	-	C
Butylate	-	-	-	F	2	2	1	4	0.05	2	0.35	-	D
Butylbenzene n-	-	-	-	D	-	-	-	-	-	-	-	-	-
Butylbenzene sec-	-	-	-	D	-	-	-	-	-	-	-	-	-
Butylbenzene tert-	-	-	-	D	-	-	-	-	-	-	-	-	-
Carbaryl	-	-	-	F	1	1	1	1	0.1	4	0.7		D
Carbofuran	F	0.04	0.04	F	0.05	0.05	0.05	0.2	0.005	0.2	0.04	-	E
Carbon tetrachloride	F	zero	0.005	F	4	0.2	0.07	0.3	0.0007	0.03	-	0.03	B2
Carboxin	-	-	-	F	1	1	1	4	0.1	4	0.7	-	D
Chloral hydrate	T	0.06	-	D	7	1.4	0.2	0.6	0.0002	0.07	0.06	-	C
Chloramben	-	-	-	F	3	3	0.2	0.5	0.015	0.5	0.1	-	D
Chlordane	F	zero	0.002	F	0.06	0.06	-	-	0.00006	0.002	-	0.003	B2
Chlorodibromomethane (THM)	T	zero	0.1*	D	7	7	2	8	0.02	0.7	0.06	-	C
Chloroethane	L	-	-	D	-	-	-	-	-	-	-	-	-
Chloroform (THM)	T	zero	0.1*	D	4	4	0.1	0.4	0.01	0.4	-	0.6	B2
Chloromethane	L	-	-	F	9	0.4	0.4	1	0.004	0.1	0.003	-	C
Chlorophenol (2-)	-	-	-	D	0.05	0.05	0.05	0.2	0.005	0.2	0.04	-	D
p-Chlorophenyl methyl sulfide/sulfone/sulfoxide	-	-	-	**	-	-	-	-	-	-	-	-	D
Chloropicrin	L	-	-	-	-	-	-	-	-	-	-	-	-
Chlorothalonil	-	-	-	F	0.2	0.2	0.2	0.5	0.015	0.5		0.15	B2
Chlorotoluene o	L			F	2	2	2	7	0.02	0.7	0.1	-	D
Chlorotoluene p	L			F	2	2	2	7	0.02	0.7	0.1		D
[illegible]				D	0.03	0.03	0.03	0.1	0.003	0.1	0.02	-	D

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Cyanogen chloride	L	-	-	-	-	-	-	-	-	-	-	-	-
Cymene p-	-	-	-	D	-	-	-	-	-	-	-	-	-
2,4-D	F	0.07	0.07	F	1	0.3	0.1	0.4	0.01	0.4	0.07	-	D
DCPA (Dacthal)	L	-	-	F	80	80	5	20	0.5	20	4	-	D
Dalapon	F	0.2	0.2	F	3	3	0.3	0.9	0.026	0.9	0.2	-	D
Di[2-ethylhexyl]adipate	F	0.4	0.4	-	20	20	20	60	0.6	20	0.4	3	C
Diazinon	-	-	-	F	0.02	0.02	0.005	0.02	0.00009	0.003	0.0006	-	E
Dibenz(a,h)anthracene (PAH)	P	zero	0.0003	-	-	-	-	-	-	-	-	-	B2
Dibromoacetonitrile	L	-	-	D	2	2	2	8	0.02	0.8	0.02	-	C
Dibromochloropropane (DBCP)	F	zero	0.0002	F	0.2	0.05	-	-	-	-	-	0.003	B2
Dibromomethane	L	-	-	-	-	-	-	-	-	-	-	-	D
Dibutyl phthalate (PAE)	-	-	-	-	-	-	-	-	0.1	4	-	-	D
Dicamba	L	-	-	F	0.3	0.3	0.3	1	0.03	1	0.2	-	D
Dichloroacetaldehyde	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloroacetic acid	T	zero	-	D	-	50	5	20	0.008	0.3	-	-	B2
Dichloroacetonitrile	L	-	-	D	1	1	0.8	3	0.008	0.3	0.006	-	C
Dichlorobenzene o-	F	0.6	0.6	F	9	9	9	30	0.09	3	0.6	-	D
Dichlorobenzene m- *	F	0.6	0.6	F	9	9	9	30	0.09	3	0.6	-	D
Dichlorobenzene p-	F	0.075	0.075	F	10	10	10	40	0.1	4	0.075	-	C
Dichlorodifluoromethane	L	-	-	F	40	40	9	30	0.2	5	1	-	D
Dichloroethane (1,1-)	L	-	-	D	-	-	-	-	-	-	-		-
Dichloroethane (1,2-)	F	zero	0.005	F	0.7	0.7	0.7	2.6	-	-	-	0.04	B2
Dichloroethylene (1,1-)	F	0.007	0.007	F	2	1	1	4	0.009	0.4	0.007	-	C
Dichloroethylene (cis-1,2-)	F	0.07	0.07	F	4	3	3	11	0.01	0.4	0.07	-	D
Dichloroethylene (trans-1,2-)	F	0.1	0.1	F	20	2	2	6	0.02	0.6	0.1	-	D
Dichloromethane	F	zero	0.005	F	10	2	-	-	0.06	2	-	0.5	B2
Dichlorophenol (2,4-)	-	-	-	D	0.03	0.03	0.03	0.1	0.003	0.1	0.02		D
Dichloropropane (1,1-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Dichloropropane (1,2-)	F	zero	0.005	F	-	0.09	-	-	-	-	-	0.05	B2
Dichloropropane (1,3-)	L	-	-	D	-	-	-	-	-	-	-	-	-

* The values for m-dichlorobenzene are based on data for o-dichlorobenzene.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Dichloropropane (2,2-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloropropene (1,1-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Dichloropropene (1,3-)	T	zero	-	F	0.03	0.03	0.03	0.1	0.0003	0.01	-	0.02	B2
Dieldrin	-	-	-	F	0.0005	0.0005	0.0005	0.002	0.00005	0.002	-	0.0002	B2
Diethyl phthalate (PAE)	-	-	-	D	-	-	-	-	0.8	30	5		D
Diethylene glycol dinitrate	-	-	-	**	-	-	-	-	-	-	-	-	-
Diethylhexyl phthalate (PAE)	F	zero	0.006	D	-	-	-	-	0.02	0.7	-	0.3	B2*
Diisopropyl methylphosphonate	-	-	-	F	8	8	8	30	0.08	3	0.6	-	D
Dimethrin	-	-	-	F	10	10	10	40	0.3	10	2	-	D
Dimethyl methylphosphonate	-	-	-	F	2	2	2	6	0.2	7	0.1	0.7	C
Dimethyl phthalate (PAE)	-	-	-	-	-	-	-	-	-	-	-		D
1,3-Dinitrobenzene	-	-	-	F	0.04	0.04	0.04	0.14	0.0001	0.005	0.001	-	D
Dinitrotoluene (2,4-)	L	-	-	F	0.50	0.50	0.30	1	0.002	0.1	-	-	-
Dinitrotoluene (2,6-)	L	-	-	F	0.40	0.40	0.40	1	0.001	0.04	-	-	-
tg 2,6 & 2,4 dinitrotoluene ***	-	-	-	-	-	-	-	-	-	-	-	*0.005*	*B2*
Dinoseb	F	0.007	0.007	F	0.3	0.3	0.01	0.04	0.001	0.04	0.007	-	D
Dioxane p-	-	-	-	F	4	0.4	-	-	-	-	-	0.7	B2
Diphenamid	-	-	-	F	0.3	0.3	0.3	1	0.03	1	0.2	-	D
Diphenylamine	-	-	-	F	1	1	0.3	1	0.03	1	0.2		D
Diquat	F	0.02	0.02	-	-	-	-	-	0.0022	0.08	0.02	-	D
Disulfoton	-	-	-	F	0.01	0.01	0.003	0.009	0.00004	0.001	0.0003	-	E
Dithiane (1,4-)	-	-	-	F	0.4	0.4	0.4	1	0.01	0.4	0.08	-	D
Diuron	-	-	-	F	1	1	0.3	0.9	0.002	0.07	0.01		D
Endothall	F	0.1	0.1	F	0.8	0.8	0.2	0.2	0.02	0.7	0.1	-	D
Endrin	F	0.002	0.002	F	0.02	0.02	0.003	0.01	0.0003	0.01	0.002		D
Epichlorohydrin	F	zero	TT	F	0.1	0.1	0.07	0.07	0.002	0.07	-	0.4	B2
Ethylbenzene	F	0.7	0.7	F	30	3	1	3	0.1	3	0.7		D
Ethylene dibromide (EDB)	F	zero	0.00005	F	0.008	0.008	-	-	-	-	-	0.00004	B2
Ethylene glycol				F	20	6	6	20	2	40	7		D
EPTC	L		-	F	0.3	0.3	0.1	0.4	0.00008	0.003	-	0.03	B2
Fenamiphos			-	F	0.009	0.009	0.005	0.02	0.00025	0.009	0.002		D

* Under review. ** A HA will not be developed due to insufficient data; a "Database Deficiency Report" has been published.

*** *tg = technical grade*

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		10-kg Child			70-kg Adult					
					One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Fluometron	-	-	-	F	2	2	2	6	0.013	0.4	0.09		D
Fluorene (PAH)	-	-	-	-	-	-	-	-	0.04	-	-	-	D
Fluorotrichloromethane	L	-	-	F	7	7	3	10	0.3	10	2	-	D
Fog Oil	-	-	-	D	-	-	-	-	-	-	-	-	-
Fonofos	-	-	-	F	0.02	0.02	0.02	0.07	0.002	0.07	0.01	-	D
Formaldehyde	-	-	-	D	10	5	5	20	0.15	5	1	-	B1
Gasoline, unleaded (benzene)	-	-	-	D	-	-	-	-	-	-	0.005	-	-
Glyphosate	F	0.7	0.7	F	20	20	1	1	0.1	4	0.7	-	D
Heptachlor	F	zero	0.0004	F	0.01	0.01	0.005	0.005	0.0005	0.02	-	0.0008	B2
Heptachlor epoxide	F	zero	0.0002	F	0.01	-	0.0001	0.0001	1.3E-0.5	0.0004	-	0.0004	B2
Hexachlorobenzene	F	zero	0.001	F	0.05	0.05	0.05	0.2	0.0008	0.03	-	0.002	B2
Hexachlorobutadiene	T	0.001	-	F	0.3	0.3	0.1	0.4	0.002	0.07	0.001	-	C
Hexachlorocyclopentadiene	F	0.05	0.05	-	-	-	-	-	0.007	0.2	-	-	D
Hexachloroethane	L	-	-	F	5	5	0.1	0.5	0.001	0.04	0.001	-	C
Hexane (n-)	-	-	-	F	10	4	4	10	-	-	-	-	D
Hexazinone	-	-	-	F	3	3	3	9	0.033	1	0.2	-	D
HMX	-	-	-	F	5	5	5	20	0.05	2	0.4	-	D
Indeno(1,2,3,-c,d)pyrene (PAH)	P	zero	0.0004	D	-	-	-	-	-	-	-	-	B2
Isophorone	L	-	-	F	15	15	15	15	0.2	7	0.1	4	C
Isopropyl methylphosphonate	-	-	-	D	30	30	30	100	0.1	4.0	0.7	-	D
Isopropylbenzene	-	-	-	D	-	-	-	-	-	-	-	-	-
Lindane	F	0.0002	0.0002	F	1	1	0.03	0.1	0.0003	0.01	0.0002	-	C
Malathion	-	-	-	D	0.2	0.2	0.2	0.8	0.02	0.8	0.2	-	D
Maleic hydrazide	-	-	-	F	10	10	5	20	0.5	20	4	-	D
MCPA	-	-	-	F	0.1	0.1	0.1	0.4	0.0015	0.05	0.01	-	E
Methomyl	L	-	-	F	0.3	0.3	0.3	0.3	0.025	0.9	0.2		D
Methoxychlor	F	0.04	0.04	F	0.05	0.05	0.05	0.2	0.005	0.2	0.04		D
Methyl ethyl ketone		-	-	-	-		-			-			*
Methyl parathion	-	-	-	F	0.3	0.3	0.03	0.1	0.00025	0.009	0.002	-	D

* Under review

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Methyl tert butyl ether	L	-	-	D	3	3	0.5	2	0.005	0.2	0.04	-	D
Metolachlor	L	-	-	F	2	2	2	5	0.15	5	0.1	-	C
Metribuzin	L	-	-	F	5	5	0.3	0.9	0.025	0.9	0.2	-	D
Monochloroacetic acid	L	-	-	D	-	-	-	-	-	-	-	-	-
Monochlorobenzene	F	0.1	0.1	F	2	2	2	7	0.02	0.7	0.1	-	D
Naphthalene	-	-	-	F	0.5	0.5	0.4	1	0.004	0.1	0.02	-	D
Nitrocellulose (non-toxic)	-	-	-	F	-	-	-	-	-	-	-	-	-
Nitroguanidine	-	-	-	F	10	10	10	40	0.1	4	0.7	-	D
Nitrophenols p-	-	-	-	D	0.8	0.8	0.8	3	0.008	0.3	0.06	-	D
Oxamyl (Vydate)	F	0.2	0.2	F	0.2	0.2	0.2	0.9	0.025	0.9	0.2	-	E
Paraquat	-	-	-	F	0.1	0.1	0.05	0.2	0.0045	0.2	0.03	-	E
Pentachloroethane	-	-	-	D	-	-	-	-	-	-	-	-	-
Pentachlorophenol	F	zero	0.001	F	1	0.3	0.3	1	0.03	1	-	0.03	B2
Phenanthrene (PAH)	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	-	-	-	D	6	6	6	20	0.6	20	4	-	D
Picloram	F	0.5	0.5	F	20	20	0.7	2	0.07	2	0.5	-	D
Polychlorinated biphenyls (PCBs)	F	zero	0.0005	P	-	-	-	-	-	-	-	0.0005	B2
Prometon	L	-	-	F	0.2	0.2	0.2	0.5	0.015*	0.5*	0.1*	-	D
Pronamide	-	-	-	F	0.8	0.8	0.8	3	0.075	3	0.05	-	C
Propachlor	-	-	-	F	0.5	0.5	0.1	0.5	0.013	0.5	0.09	-	D
Propazine	-	-	-	F	1	1	0.5	2	0.02	0.7	0.01	-	C
Propham	-	-	-	F	5	5	5	20	0.02	0.6	0.1	-	D
Propylbenzene n-	-	-	-	D	-	-	-	-	-	-	-	-	-
Pyrene (PAH)	-	-	-	-	-	-	-	-	0.03	-	-	-	D
RDX	-	-	-	F	0.1	0.1	0.1	0.4	0.003	0.1	0.002	0.03	C
Simazine	F	0.004	0.004	F	0.07	0.07	0.07	0.07	0.005	0.2	0.004	-	C
Styrene	F	0.1	0.1	F	20	2	2	7	0.2	7	0.1		C
2,4,5-T	L	-	-	F	0.8	0.8	0.8	1	0.01	0.35	0.07	-	D
2,3,7,8-TCDD (Dioxin)	F	zero	3E-08	F	1E-08	1E-07	1E-08	4E-08	1E-09	4E-08	-	2E-08	B2

* Under review NOTE: Phenanthrene – not proposed.

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Tebuthiuron	-	-	-	F	3	3	0.7	2	0.07	2	0.5	-	D
Terbacil	-	-	-	F	0.3	0.3	0.3	0.9	0.013	0.4	0.09	-	E
Terbufos	-	-	-	F	0.005	0.005	0.001	0.005	0.00013	0.005	0.0009	-	D
Tetrachloroethane (1,1,1,2-)	L	-	-	F	2	2	0.9	3	0.03	1	0.07	0.1	C
Tetrachloroethane (1,1,2,2-)	L	-	-	D	-	-	-	-	-	-	-	-	-
Tetrachloroethylene	F	zero	0.005	F	2	2	1	5	0.01	0.5	-	0.07	-
Tetranitromethane	-	-	-	**	-	-	-	-	-	-	-	-	-
Toluene	F	1	1	F	20	2	2	7	0.2	7	1	-	D
Toxaphene	F	zero	0.003	F	0.5	0.04	-	-	0.1	0.0035	-	0.003	B2
2,4,5-TP	F	0.05	0.05	F	0.2	0.2	0.07	0.3	0.0075	0.3	0.05	-	D
1,1,2-Trichloro-1,2,2-trifluoroethane	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroacetic acid	T	0.1	-	D	-	2	4	13	0.04	1.3	1	-	C
Trichloroacetonitrile	L	-	-	D	0.05	0.05	-	-	-	-	-	-	-
Trichlorobenzene (1,2,4-)	F	0.07	0.07	F	0.1	0.1	0.1	0.5	0.01	0.4	0.07	-	D
Trichlorobenzene (1,3,5-)	-	-	-	F	0.6	0.6	0.6	2	0.006	0.2	0.04	-	D
Trichloroethane (1,1,1-)	F	0.2	0.2	F	100	40	40	100	0.035	1	0.2	-	D
Trichloroethane (1,1,2-)	F	0.003	0.005	F	0.6	0.4	0.4	1	0.004	0.1	0.003	-	C
Trichloroethanol (2,2,2-)	L	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethylene	F	zero	0.005	F	-	-	-	-	-	0.3	-	0.3	B2
Trichlorophenol (2,4,6-)	L	-	-	D	-	-	-	-	-	-	-	0.3	B2
Trichloropropane (1,1,1-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Trichloropropane (1,2,3-)	L	-	-	F	0.6	0.6	0.6	2	0.006	0.2	0.04	-	B2
Trifluralin	L	-	-	F	0.08	0.08	0.08	0.3	0.0075	0.3	0.005	-	C
Trimethylbenzene (1,2,4-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Trimethylbenzene (1,3,5-)	-	-	-	D	-	-	-	-	-	-	-	-	-
Trinitroglycerol	-	-	-	F	0.005	0.005	0.005	0.005	-	-	0.005	-	-
Trinitrotoluene		-	-	F	0.02	0.02	0.02	0.02	0.0005	0.02	0.002	0.1	C
Vinyl chloride	F	zero	0.002	F	3	3	0.01	0.05	-	-	-	0.0015	A
Xylenes	F	10	10	F	40	40	40	100	2	80	10	-	D

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-6} Cancer Risk	
INORGANICS													
Aluminum	L	-	-	D	-	-	-	-	-	-	-	-	-
Ammonia	-	-	-	D	-	-	-	-	-	-	30	-	D
Antimony	F	0.006	0.006	F	0.015	0.015	0.015	0.015	0.0004	0.015	0.003		D
Arsenic	*	-	0.05	D	-	-	-	-	-	-	-	0.002	A
Asbestos (fibers/l >10μm length)	F	7 MFL	7 MFL	-	-	-	-	-	-	-	-	700 MFL	A
Barium	F	2	2	F	-	-	-	-	0.07	2	2		D
Beryllium	F	0.004	0.004	D	30	30	4	20	0.005	0.2	-	0.0008	B2
Boron	L	-	-	D	4	0.9	0.9	3	0.09	3	0.6	*	*D*
Cadmium	F	0.005	0.005	F	0.04	0.04	0.005	0.02	0.0005	0.02	0.005	-	D
Chloramine	*T*	*4*	-	D	1	1	1	1	0.1	3.3	2.6	-	-
Chlorate	L	-	-	D	-	-	-	-	-	-	-	-	-
Chlorine	*T*	*4*	-	D	-	-	-	-	-	-	-	-	*D*
Chlorine dioxide	*T*	*0.08*	-	D	-	-	-	-	*0.003*	*0.1*	*0.08*		*D*
Chlorite	L	-	-	D	-	-	-	-	-	-	-	-	*D*
Chromium (total)	F	0.1	0.1	F	1	1	0.2	0.8	0.005	0.2	0.1	-	D
Copper	F	1.3	TT**	-	-	-	-	-	-	-	-	-	D
Cyanide	P	0.2	0.2	F	0.2	0.2	0.2	0.8	0.022	0.8	0.2	-	D
Fluoride*	F	4	4	-	-	-	-	-	0.12	-	-	-	-
Hypochlorite	*T*	*4*	-	-	-	-	-	-	-	-	-		-
Hypochlorous acid	*T*	*4*	-	-	-	-	-	-	-	-	-	-	-
Lead (at tap)	F	zero	TT**	-	-	-	-	-	-	-	-		B2
Manganese	L	0.2	-	D	-	-	-	-	0.14/ 0.005	-	-	-	-
Mercury (inorganic)	F	0.002	0.002	F	-	-		0.002	0.0003	0.01	0.002		D
Molybdenum	L	-	-	F	-	0.08	0.01	0.05	0.005	0.2	0.04	-	D
Nickel	F	0.1	0.1	F	1	1	0.5	1.7	0.02	0.6	0.1		D
[illegible]	-	[illegible]	[illegible]	F		10*	-	-	1.6				*

Drinking Water Standards and Health Advisories

Chemicals	Standards			Status HA	Health Advisories								Cancer Group
					10-kg Child			70-kg Adult					
	Status Reg.	MCLG (mg/l)	MCL (mg/l)		One-day (mg/l)	Ten-day (mg/l)	Longer-term (mg/l)	Longer-term (mg/l)	RfD (mg/kg/day)	DWEL (mg/l)	Lifetime (mg/l)	mg/l at 10^{-4} Cancer Risk	
Nitrite (as N)	F	1	1	F	-	1*	-	-	0.16*	-	-	-	*
Nitrate + Nitrite (both as N)	F	10	10	F	-	-	-	-	-	-	-	-	*
Selenium	F	0.05	0.05	-	-	-	-	-	0.005	-	-	-	-
Silver	-	-	-	D	0.2	0.2	0.2	0.2	0.005	0.2	0.1	-	D
Sodium	-	-	-	D	-	-	-	-	-	20***	-	-	-
Strontium	L	-	-	D	25	25	25	90	0.6	90	17	-	D
Sulfate	P	**	**	-	-	-	-	-	-	-	-	-	
Thallium	F	0.0005	0.002	F	0.007	0.007	0.007	0.02	0.00007	0.002	0.0004	-	
Vanadium	L	-	-	D	-	-	-	-	-	-			D
White phosphorous	-	-	-	F	-	-	-	-	0.00002	0.0005	0.0001		D
Zinc	L	-	-	F	6	6	3	12	0.3	11	2	-	D
Zinc chloride (measured as Zinc)	L	-	-	F	6	6	3	12	0.3	11	2	-	D
RADIONUCLIDES													
Beta particle and photon activity (formerly man-made radionuclides)	P	zero	4 mrem	-	-	-	-	-	-	-	-	4 mrem/y	A
Gross alpha particle activity	P	zero	15 pCi/L	-	-	-	-	-	-	-	-	15 pCi/L	A
Radium 226	P	zero	20 pCi/L	-	-	-	-	-	-	-	-	20 pCi/L	A
Radium 228	P	zero	20 pCi/L	-	-	-	-	-	-	-	-	20 pCi/L	A
Radon	P	zero	300 pCi/L	-	-	-	-	-	-	-	-	150 pCi/L	A
Uranium	P	30 µg/L	20 µg/L	-	-	-	-	-	-	-	-	70 µg/L	A

* Under review.
** Deferred.
*** Guidance.

Secondary Maximum Contaminant Levels

Chemicals	Status	SMCLs (mg/L)
Aluminum	F	0.05 to 0.2
Chloride	F	250
Color	F	15 color units
Copper	F	1.0
Corrosivity	F	non-corrosive
Fluoride*	F	2.0
Foaming agents	F	0.5
Iron	F	0.3
Manganese	F	0.05
Odor	F	3 threshold odor numbers
pH	F	6.5 – 8.5
Silver	F	0.1
Sulfate	F	250
Total dissolved solids (TDS)	F	500
Zinc	F	5

Status Codes: P – proposed, F – final

* Under review.

Microbiology

	Status	MCLG	MCL
Cryptosporidium	L	-	-
Giardia lamblia	F	zero	TT
Legionella	F′	zero	TT
Standard Plate Count	F′	NA	TT
Total Coliforms (after 12/31/90)	F	zero	••
Turbidity (after 12/31/90)	F	NA	PS
Viruses	F′	zero	TT

Key: PS, TT, F, defined as previously stated.

′ Final for systems using surface water; also being considered for regulation under groundwater disinfection rule.

COMMONWEALTH OF VIRGINIA

STATE WATER CONTROL BOARD

REGULATIONS

Water Quality Standards

Water Quality Standards (VR 680-21-00)

Effective May 20, 1992

VR680-21-04.2 - Anti-degradation Policy for Groundwater

If the concentration of any constituent in groundwater is less than the limit set forth by groundwater standards, the natural quality for the constituent shall be maintained; natural quality shall also be maintained for all constituents, including temperature, not set forth in groundwater standards. If the concentration of any constituent in groundwater exceeds the limit in the standard for that constituent, no addition of that constituent to the naturally occurring concentration shall be made. Variance to this policy shall not be made unless it has been affirmatively demonstrated that a change is justifiable to provide necessary economic or social development, that the degree of waste treatment necessary to preserve the existing quality cannot be economically or socially justified, and that the present and anticipated uses of such water will be preserved and protected.

GROUNDWATER QUALITY STANDARDS

PHYSIOGRAPHIC PROVINCES

1 Coastal Plain

2 Piedmont and Blue Ridge

3 Valley and Ridge

4 Cumberland Plateau

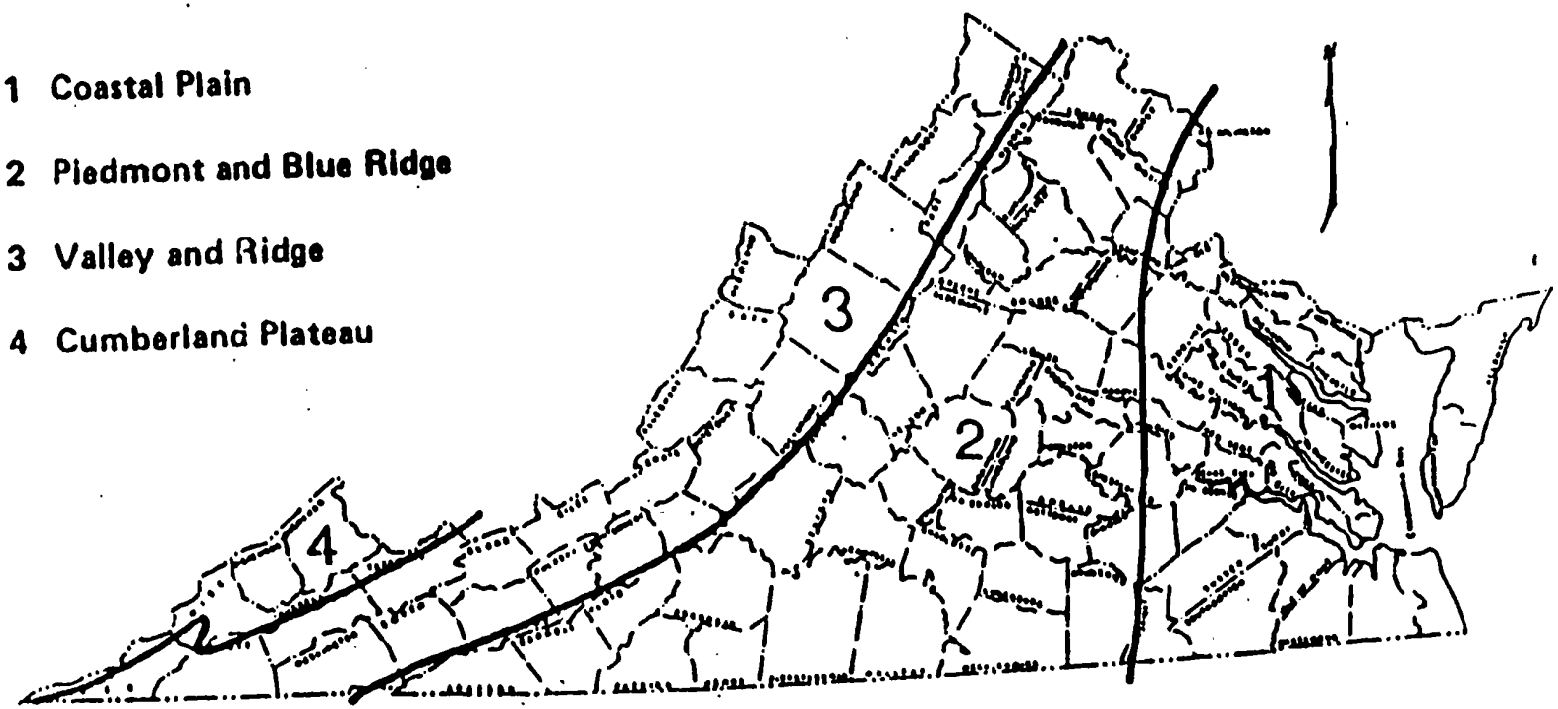


FIGURE 1 Water Quality Standards - 5/20/92

VR680-21-04.3 Groundwater Standards Applicable Statewide

CONSTITUENT	CONCENTRATION	
Sodium	270	mg/l
Foaming Agents as methylene blue active substances	0.05	mg/l
Petroleum hydrocarbons	1	mg/l
Arsenic	0.05	mg/l
Barium	1.0	mg/l
Cadmium	0.0004	mg/l
Chromium	0.05	mg/l
Copper	1.0	mg/l
Cyanide	0.005	mg/l
Lead	0.05	mg/l
Mercury	0.00005	mg/l
Phenols	0.001	mg/l
Selenium	0.01	mg/l
Silver	None	
Zinc	0.05	mg/l
Chlorinated Hydrocarbon Insecticides		
Aldrin/Dieldrin	0.003	ug/l
Chlordane	0.01	ug/l
DDT	0.001	ug/l
Endrin	0.004	ug/l
Heptachlor	0.001	ug/l
Heptachlor Epoxide	0.001	ug/l
Kepone	None	
Lindane	0.01	ug/l
Methoxychlor	0.03	ug/l
Mirex	None	
Toxaphene	None	
Chlorophenoxy Herbicides		
2,4-D	0.1	mg/l
Silvex	0.01	mg/l
Radioactivity		
Total Radium (Ra-226 & Ra-228)	5	pCi/l
Radium 226	3	pCi/l
Gross Beta Activity*	50	pCi/l
Gross Alpha Activity (excluding Radon & Uranium)	15	pCi/l
Tritium	20,000	pCi/l
Strontium-90	8	pCi/l
Manmade Radioactivity - Total Dose Equiv.**	4	mrem/yr

pCi/l = picocurie per liter
mrem/yr = millirems per year

*The gross beta value shall be used as a screening value only. If exceeded the water must be analyzed to determine the presence and quantity of radionuclids to determine compliance with the tritium, strontium, and manmade radioactivity standards.

**Combination of all sources should not exceed total dose equivalent of 4 mrem/year.

VR680-21-04.4 Groundwater Standards Applicable by Physiographic Province

CONSTITUENT	CONCENTRATION			
	Coastal Plain	Piedmont & Blue Ridge	Valley & Ridge	Cumberland Plateau
pH	6.5-9	5.5-8.5	6-9	5-8.5
Ammonia Nitrogen	0.025 mg/l	0.025 mg/l	0.025 mg/l	0.025 mg/l
Nitrite Nitrogen	0.025 mg/l	0.025 mg/l	0.025 mg/l	0.025 mg/l
Nitrate Nitrogen	5 mg/l	5 mg/l	5 mg/l	0.5 mg/l

VR680-21-05 WATER QUALITY CRITERIA FOR GROUNDWATER

VR680-21-05.1 General Requirements

These groundwater quality criteria apply primarily to groundwater constituents that occur naturally. Since natural groundwater quality can vary greatly from area to area for these constituents, enforceable standards were not adopted. These criteria are intended to provide guidance in preventing groundwater pollution. Groundwater criteria carry the same regulatory limitation as surface water criteria: they are not mandatory.

VR680-21-05.2 Groundwater Criteria

CONSTITUENT (mg/l)	GROUNDWATER CRITERIA BY PHYSIOGRAPHIC PROVINCE***			
	Coastal Plain	Piedmont & Blue Ridge	Valley & Ridge	Cumberland Plateau
Alkalinity	30-500	10-200	30-500	30-200
Total Diss. Solids	1000	250	500	500
Chloride	50*	25	25	25
Sulfate	50	25	100	150
Total Organic Carbon	10	10	10	10

CONSTITUENT (mg/l)	GROUNDWATER CRITERIA BY PHYSIOGRAPHIC PROVINCE***			
	Coastal Plain	Piedmont & Blue Ridge	Valley & Ridge	Cumberland Plateau
Color units	15	15	15	15
Iron	0.3	0.3	0.3	0.01-10
Manganese	0.05	0.05	0.05	0.01-0.5
Sodium	100*	25	25	100
Fluoride	1.4**	1.4	1.4	1.4
Hardness	120	120	300	180

* It is recognized that naturally occurring concentrations will exceed this limit in the eastern part of the Coastal Plain, especially toward the shoreline and with increased depth.

** Except within the cretaceous aquifer: concentration up to 5 mg/l and higher.

*** See Figure 1, for delineation of physiographic provinces.

VR680-21-06 PROCEDURAL REQUIREMENTS

VR680-21-06.1 Variance in Standards

A. The above standards notwithstanding, as a result of natural conditions, water quality may from time to time vary from established limits as a result of natural conditions.

B. When the maximum temperature of put and take trout waters exceeds, solely due to natural conditions, the maximum allowable temperature standard specified in Section VR680-21-01.5, the Board, on a case-by-case basis, may grant a variance to the maximum temperature standard and will use the naturally occurring maximum temperature in setting effluent limits in permits. The public notice for any permit proposed to be issued or reissued by the Board will contain reference to any proposed granting of such a variance.

C. Variances under Section 3.16(a) of the Clean Water Act and under B. above are site-specific case decisions that do not require a standards amendment.

VR680-21-06.2 Modification, Amendment, and Cancellation of Standards

Under the authority of Section 62.1-44.15(3)(b) of the State Water Control Law, the Board reserves the right at any time to modify, amend, or cancel any of the rules, policies, or standards set forth herein. Such modification, amendment, or cancellation shall be consistent with requirements of Section 303 of the Clean Water Act, as amended, and regulations promulgated thereunder.

VR680-21-06.3 Shellfish Buffer Zones - Public Hearing

Before acting on any proposal for a project that, while not contravening established numeric standards for shellfish waters, would result in condemnation by the State Health Department of shellfish beds, the Board shall convene a public hearing to determine the socio-economic effect of the proposal. Such proposals include discharge of treated waste or proposals to otherwise alter the biological, chemical or physical properties of State waters. If the Marine Resources Commission or the Virginia Institute of Marine Science certify that the project would have no effect on the shellfish use now and in the foreseeable future, the Board may dispense with such hearing.

When the Board finds that the proposed project will result in shellfish bed condemnation and if the condemnation will violate the general standard, it shall disapprove the proposal.

VR680-21-06.4 Analytical Procedures

Analytical testing should be done in accordance with accepted procedures in 40 CFR 136, as amended or other Board/EPA recognized and approved methods.

VR680-21-06.5 Tidal Water Sampling

Samples for determining compliance with standards established for estuarine or open ocean waters shall be collected at slack before flood tide or slack before ebb tide.

VR680-21-06.6 Classification of Tributary Streams

Any tributary stream which is not named in a specific section description, or otherwise, shall carry the same classification and standards of quality assigned to the stream or section to which it is tributary, except in the case of trout streams. Streams classified as trout waters are specifically named.

VR680-21-07 SPECIAL STANDARDS AND DESIGNATIONS

VR680-21-07.1 Special Standards and Requirements

The special standards are shown in small letters to correspond to lettering in the basin tables. The special standards are as follows:

VR680-21-01.14 Standards for Surface Water

A. Instream water quality conditions shall not be acutely or chronically toxic except for toxicity as allowed for in VR680-21-01.2.C (mixing zones). The following are definitions of acute and chronic toxicity conditions.

Acute Toxicity means an adverse effect that usually occurs shortly after the introduction of a pollutant. Lethality to an organism is the usual measure of acute toxicity. Where death is not easily detected immobilization is considered equivalent to death.

Chronic Toxicity means an adverse effect that is irreversible or progressive or occurs because the rate of injury is greater than the rate of repair during prolonged exposure to a pollutant. This includes low level, long-term effects such as reduction in growth or reproduction.

B. The following table is a list of numerical water quality standards for specific parameters.

1. For those waters with multiple designated beneficial uses, the most stringent standards in the following table shall apply.

2. When information has become available from the Environmental Protection Agency to calculate additional aquatic life or human health standards not contained in the table the Board may employ these values in establishing effluent limitations or other limitations pursuant to the General Standard in VR680-21-01.2 necessary to protect the beneficial uses until the Board has completed the regulatory standards adoption process.

Table of Parameters

	AQUATIC LIFE				HUMAN HEALTH	
	FRESHWATER		SALTWATER		PUBLIC WATER	ALL OTHER
SUBSTANCE[1]	ACUTE[2] ug/l	CHRONIC[3] ug/l	ACUTE[2] ug/l	CHRONIC[3] ug/l	SUPPLIES[4] ug/l	SURFACE WATERS[5] ug/l
Aldrin c	3.0	0.3	1.3	0.13	0.0013	0.0014
Ammonia	See Table 1	See Table 2	See Tables 3 and 4			
Anthracene					9,600	110,000
Arsenic					50	
Arsenic III	360	190	69	36		
Barium					2,000	
Benzene c					12	710

VR680-21-01.14.B continued...

SUBSTANCE[1]	AQUATIC LIFE FRESHWATER ACUTE[2] ug/l	FRESHWATER CHRONIC[3] ug/l	SALTWATER ACUTE[2] ug/l	SALTWATER CHRONIC[3] ug/l	HUMAN HEALTH PUBLIC WATER SUPPLIES[4] ug/l	HUMAN HEALTH ALL OTHER SURFACE WATERS[5] ug/l
Benzo(a)anthracene c					0.028	0.311
Benzo(b)fluoranthene c					0.028	0.311
Benzo(k)fluoranthene c					0.028	0.311
Benzo(a)pyrene c					0.028	0.311
Bromoform c					44	3,600
Cadmium	$e^{(1.128[\ln(hardness^*)]-3.828)}$	$e^{(0.7852[\ln(hardness^*)]-3.490)}$	43	9.3	16	170
Carbon Tetrachloride c					2.5	45
Chlordane c	2.4	0.0043	.09	0.0040	0.0058	0.0059
Chloride	860,000	230,000			250,000**	
Chlorine	See VR680-21-01.1,1					
Chlorodibromomethane					690	57,000
Chloroform c					57	4,700
Chloromethane c					57	4,700
Chlorpyrifos	0.083	0.041	0.011	0.0056		
Chromium III	$e^{(0.8190[\ln(hardness^*)]+3.688)}$	$e^{(0.8190[\ln(hardness^*)]+1.561)}$			33,000	670,000
Chromium VI	16	11	1,100	50	170	3,400

VR680-21-01.14.B continued...

SUBSTANCE[1]	AQUATIC LIFE: FRESHWATER ACUTE[2] ug/l	FRESHWATER CHRONIC[3] ug/l	SALTWATER ACUTE[2] ug/l	SALTWATER CHRONIC[3] ug/l	HUMAN HEALTH: PUBLIC WATER SUPPLIES[4] ug/l	ALL OTHER SURFACE WATERS[5] ug/l
Chrysene c					0.028	0.311
Copper	$e^{(0.9422[\ln(hardness^*)]-1.464)}$	$e^{(0.8545[\ln(hardness^*)]-1.465)}$	2.9	2.9	1,300	
Cyanide	22	5.2	1.0	1.0	700	215,000
DDT c	1.1	0.0010	0.13	0.0010	0.0059	0.0059
Demeton		0.1		0.1		
Dibenz(a,h)anthracene c					0.028	0.311
Dichloromethane c					47	16,000
1,2-Dichlorobenzene					2,700	17,000
1,3-Dichlorobenzene					400	2,600
1,4-Dichlorobenzene					400	2,600
Dichlorobromomethane c					3.0	220
1,2-Dichloroethane c					3.8	990
(2,4-dichlorophenoxy) acetic acid (2,4-D)					71	
Dieldrin c	2.5	0.0019	0.71	0.0019	0.0014	0.0014
Di-2-Ethylhexyl Phthalate c					18	59
2,4-Dinitrotoluene c					1.1	91

VR680-21-C1.14.B continued...

SUBSTANCE[1]	AQUATIC LIFE FRESHWATER ACUTE[2] ug/l	FRESHWATER CHRONIC[3] ug/l	SALTWATER ACUTE[2] ug/l	SALTWATER CHRONIC[3] ug/l	HUMAN HEALTH PUBLIC WATER SUPPLIES[4] ug/l	HUMAN HEALTH ALL OTHER SURFACE WATERS[5] ug/l
Dioxin	See VR680-21-01.15					
Dissolved Oxygen	See VR680-21-01.5					
Endosulfan	0.22	0.056	0.034	0.0087	0.93	2.0
Endrin	0.18	0.0023	0.037	0.0023	0.76	0.81
Ethylbenzene					3,100	29,000
Fluoranthene					300	370
Fluorene					1,300	14,000
Foaming agents (measured as methylene blue active substances)					500**	
Guthion		0.01		0.01		
Heptachlor c	0.52	0.0038	0.053	0.0036	0.0021	0.0021
Hexachlorocyclohexane (Lindane)	2.0	0.080	0.16	0.01	7	25
Hydrogen Sulfide		2.0		2.0		
Indeno(1,2,3-cd)pyrene c					0.028	0.311
Iron (soluble)					300**	
Isophorone					6,900	490,000
Kepone		zero		zero		

VR680-21-01.14.B continued...

SUBSTANCE[1]	AQUATIC LIFE FRESHWATER ACUTE[2] ug/l	FRESHWATER CHRONIC[3] ug/l	SALTWATER ACUTE[2] ug/l	SALTWATER CHRONIC[3] ug/l	HUMAN HEALTH PUBLIC WATER SUPPLIES[4] ug/l	HUMAN HEALTH ALL OTHER SURFACE WATERS[5] ug/l
Lead	$e^{(1.273[\ln(hardness^*)]-1.460)}$	$e^{(1.273[\ln(hardness^*)]-4.705)}$	220	8.5	15	
Malathion		0.1		0.1		
Manganese (soluble)					50**	
Mercury[6][7]	2.4	0.012	2.1	0.025	0.144	0.146
Methoxyclor		0.03		0.03	40	
Mirex		zero		zero		
Monochlorobenzene					680	21,000
Nickel	$e^{(0.8460[\ln(hardness^*)]+3.3612)}$	$e^{(0.8460[\ln(hardness^*)]+1.1645)}$	75	8.3	607	4,583
Nitrate (as N)					10,000	
Parathion	0.065	0.013				
PCB-1242 c		0.014		0.030	0.00044	0.00045
PCB-1254 c		0.014		0.030	0.00044	0.00045
PCB-1221 c		0.014		0.030	0.00044	0.00045
PCB-1232 c		0.014		0.030	0.00044	0.00045
PCB-1248 c		0.014		0.030	0.00044	0.00045
PCB-1260 c		0.014		0.030	0.00044	0.00045

SUBSTANCE[1]	AQUATIC LIFE FRESHWATER ACUTE[2] ug/l	FRESHWATER CHRONIC[3] ug/l	SALTWATER ACUTE[2] ug/l	SALTWATER CHRONIC[3] ug/l	HUMAN HEALTH PUBLIC WATER SUPPLIES[4] ug/l	HUMAN HEALTH ALL OTHER SURFACE WATERS[5] ug/l
PCB-1016 c		0.014		0.030	0.00044	0.00045
Pentachlorophenol c	$e^{(1.005(pH)-4.830)}$	$e^{(1.005(pH)-5.290)}$	13	7.9	2.8	82
pH	See VR680-21-01.5					
Phenol					21,000	4,600,000
Phosphorus (Elemental)				0.10		
Pyrene					960	11,000
Radioactivity	See VR680-21-01.12					
Selenium	20	5.0	300	71	172	11,200
Silver	$e^{(1.72[\ln(hardness)]-6.52)}$		2.3			
Sulfate					250,000**	
Temperature	See VR680-21-01.5					
Tetrachloroethylene					318	3,519
Toluene					6,800	200,000
Total dissolved solids					500,000**	
Toxaphene[6] c	0.73	0.0002	0.21	0.0002	0.0073	0.0075
Trichloroethylene c					27	807

VR680-21-01.14.B continued...

SUBSTANCE[1]		AQUATIC LIFE FRESHWATER ACUTE[2] ug/l	AQUATIC LIFE FRESHWATER CHRONIC[3] ug/l	AQUATIC LIFE SALTWATER ACUTE[2] ug/l	AQUATIC LIFE SALTWATER CHRONIC[3] ug/l	HUMAN HEALTH PUBLIC WATER SUPPLIES[4] ug/l	HUMAN HEALTH ALL OTHER SURFACE WATERS[5] ug/l
2,4,6-Trichlorophenol	c					21	65
2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)						50	
Tributyltin		See VR680-21-01.13					
Vinyl Chloride	c					20	5,250
Zinc		$e^{(0.8473[\ln(hardness^*)]+0.8604)}$	$e^{(0.8473[\ln(hardness^*)]+0.7614)}$	95	86	5,000**	

[1] = Unless specifically listed above, all metals shall be measured as dissolved.
[2] = One hour average concentration not to be exceeded more than once every three years.
[3] = Four day average concentration not to be exceeded more than once every three years.
[4] = Unless otherwise noted, these standards have been calculated to protect human health from toxic effects through drinking water and fish consumption.
[5] = Unless otherwise noted, these standards have been calculated to protect human health from toxic effects through fish consumption.
[6] = Chronic aquatic life values have been calculated to protect wildlife from harmful effects through ingestion of contaminated tissue. However, the standard will also protect aquatic life from toxic effects.
[7] = Chronic aquatic life standard applies to methyl mercury.
* = Hardness as calcium carbonate mg/L $CaCO_3$ The minimum hardness allowed for use in this equation shall not be less than 25 mg/L, as calcium carbonate, even if the actual ambient hardness is less than 25 mg/L as calcium carbonate. The maximum hardness value for use in this equation shall not exceed 400 mg/L as calcium carbonate, even if the actual ambient hardness is greater than 400 mg/L as calcium carbonate.
** = To maintain acceptable taste, odor or aesthetic quality of drinking water.
c = Known or suspected carcinogen, human health standards are for a risk level of 10^{-5}.

APPENDIX M

Toxicology Profiles

APPENDIX M

ALUMINUM

INTRODUCTION

Chemical Name:	Aluminum
CAS RN:	7429905
Molecular Formula:	Al
Molecular Weight:	26.98

Tin-white, malleable, ductile metal, with somewhat bluish tint; capable of taking brilliant polish which is retained in dry air. Aluminum, as pure metal or as alloys, uses include utensils, aircraft, apparatus, electrical conductors. The coarse powder is used in aluminothermics; the fine powder as flashlight in photography, in explosives, fireworks and in aluminum paints, etc.

FATE AND TRANSPORT

Solubility:	Soluble in dilute HCl, H_2SO_4 and alkalines
Vapor Pressure:	1 mm Hg @ 1284°C
Specific Gravity:	2.702

HUMAN EFFECTS

Aluminum is not generally regarded as in industrial poison. Inhale of finely divided aluminum powder has been reported as a cause of pulmonary fibrosis. May be implicated in alzheimers disease.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogen Classification:	Group D - not classified as a carcinogen

Noncarcinogenic Effects

Oral RfD(1):	2.9 mg/kg/day

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

3. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

ARSENIC

INTRODUCTION

Chemical Name:	Arsenic
CAS RN:	7440-38-2
Molecular Formula:	As
Molecular Weight:	74.92 g/mole

Arsenic (elemental) exists as a silvery to black, brittle, crystalline and amorphous metalloid. Arsenic is used in the production of glass, enamels, ceramics, oil, cloth, linoleum, electrical semiconductors, pigments, fireworks, pesticides, fungicides, veterinary pharmaceuticals and wood preservatives.

FATE AND TRANSPORT

BCF(1):	Accumulates to toxic levels in food chain organisms
Solubility:	
In Water:	Insoluble
In Organics:	Unknown (5); soluble in nitric acid
Vapor Pressure:	1 mm Hg @ 372°C (sublimes)
Specific Gravity:	5.727

HUMAN HEALTH EFFECTS

Principal toxic forms are trivalent arsenic compounds. Arsenic and its compounds may cause cardiac arrhythmia, anorexia, peripheral neuropathy, cirrhosis, jaundice, peripheral vascular disease and bladder, lung, liver, kidney, skin and colon cancer.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1): Group A - human carcinogen

Noncarcinogenic Effects

Oral RfD(1): 3×10^{-4} mg/kg/day

Carcinogenic Effects

Oral CSF(1):	1.75 $(mg/kg/day)^{-1}$
Inhalation CSF(1):	15.1 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. Dangerous Properties of Industrial Materials. Van Nostrand Reinhold Company, Inc. New York, New York. 1984.

4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

BARIUM

INTRODUCTION

Chemical Name:	Barium
CAS RN:	7440-39-3
Molecular Formula:	Ba
Molecular Weight:	137.3 g/mole

Barium is a silvery-white, slightly lustrous, somewhat malleable metal. Its uses include various alloys, paints, soap, paper, and rubber, and in the manufacture of ceramics and glass. Barium compounds also are used in diagnostic radiology.

FATE AND TRANSPORT

BCF(1):	Not Significant
Solubility(1):	
In Water:	Decomposes; combines with sulfate present in natural waters to form $BaSO_4$, which has a solubility of 1.6 mg/L @ 20°C
In Organics:	Soluble in alcohol, insoluble in benzene
Vapor Pressure:	Not Reported
Specific Gravity:	3.5

Barium is extremely reactive, decomposes in water, and readily forms insoluble carbonate and sulfate salts. It is generally present in surface water and groundwater only in trace amounts.

HUMAN HEALTH EFFECTS

Noncarcinogenic Effects

Soluble salts of barium, such as barium chloride and barium carbonate, are highly toxic by exposure via ingestion.

The most important effect of acute barium poisoning is a strong, prolonged stimulant action of muscle including smooth, cardiac, and skeletal muscles. This tends to lead to a transient increase in blood pressure due to vasoconstriction. Effects on the hematopoietic system and cerebral cortex have also been reported in humans. Accidental ingestion of soluble barium salts has resulted in gastroenteritis, muscular paralysis and ventricular fibrillation.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogen Classification:	Group D - not classified as a carcinogen
Noncarcinogenic Effects	
Oral RfD:	$7x10^{-2}$ mg/kg/day
Inhalation RFD(2)	$1.43x10^{-4}$ mg/kg/day

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

BENZO(a)ANTHRACENE

INTRODUCTION

Chemical Name:	Benz(a)anthracene
CAS RN:	56553
Molecular Formula:	$C_{18}H_{12}$
Molecular Weight:	228.30

Substance comprised of colorless plates from glacial acetic acid or alcohol which sometimes exhibit greenish-yellow fluorescence.

FATE AND TRANSPORT

BCF:	Not Significant
Solubility:	Insoluble in water
	Soluble in most organic solvents

HUMAN HEALTH EFFECTS

Benzo(a)anthracene administration caused increase in the incidence of tumors. Although there are no human data that specifically link exposure of benzo(a) anthracene to human cancers, it is a component of mixtures that have been associated with human cancer.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1):	Group B-2 - animal carcinogen

Carcinogenic Effects	
Oral CSF(1):	1.06 $(mg/kg/day)^{-1}$
Inhalation CSF(1):	0.885 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

BENZO(b)FLUORANTHENE

INTRODUCTION

Chemical Name:	Benz(e)acephenanthrylene
CAS RN:	205992
Molecular Formula:	$C_{20}H_{12}$
Molecular Weight:	252.32

HUMAN HEALTH EFFECTS

Benzo(b)fluoranthene has been shown to increase the incidence of tumors in animal studies.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1):	Group B-2 - animal carcinogen
Carcinogenic Effects	
Oral CSF(1):	0.896 $(mg/kg/day)^{-1}$
Inhalation CSF(1):	0.749 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

BENZO(k)FLUORANTHENE

INTRODUCTON

Chemical Name:	Benzo(k) fluoranthene
CAS RN:	207089
Molecular Formula:	$C_{20}H_{12}$
Molecular Weight:	252.32

HUMAN HEALTH EFFECTS

Benzo(k)fluoranthene has been shown to increase the incidence of tumors in animal studies.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carocinogenic Classificatoin(4):	Group B-2 animal carcinogen
Carcinogenic Effects	
Oral CSF(4):	0.388 (mg/kg/day)
Inhalation CSF(4)	0.325 (mg/kg/day)

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. USEPA Region III, Setting Exposure Routes and Contaminants of Concern By Risk-Based Screening, USEPA Region III, Philadelphia, PA, EPA/903/R093-0-01, January, 1993.

5. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

BENZO(a)PYRENE

INTRODUCTION

Chemical Name:	Benzo(a)Pyrene
CAS RN:	50328
Molecular Formula:	$C_{20}H_{12}$
Molecular Weight:	252.32

Benzo(a)pyrene is comprised of monoclinic or orthorhombic crystals. These crystals form yellowish plates.

FATE AND TRANSPORT

BCF:	Practically insoluble in water Soluble in benzene, toluene, tylene, alcohol, methanol

HUMAN HEALTH EFFECTS

Benzo(a)pyrene has been demonstrated to cause stomach tumors in mice, rats and hamsters. Lung cancer has been shown to be induced in humans in various mixtures containing benzo(a)pyrene.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1):	Group B-2 - animal carcinogen

Carcinogenic Effects	
Oral CSF(1):	7.30 $(mg/kg/day)^{-1}$
Inhalation CSF(2):	6.10 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand

Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual, Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

BERYLLIUM

INTRODUCTION

Chemical Name:	Beryllium
CAS RN:	7440417
Molecular Formula:	Be
Molecular Weight:	9.01 g/mole

A grayish-white metal exhibiting a local steel-like hardness in a thin film of oxide on the metal. Beryllium's uses include neutron reflector and moderator in nuclear reactors. In its compound forms uses include radio tube parts, television tube phosphors, fluorescent tubes and fluorescent powders.

FATE AND TRANSPORT

BCF:	19
Solubility:	Soluble in acids and caustic solutions
Specific Gravity:	1.85

HUMAN HEALTH EFFECTS

Alloys containing Be are dangerous. Be compounds may act locally on the skin. Exposure to Be compounds encountered in the extraction of the metal or its oxide from the ore, particularly the halide salts, has been attended, in certain individuals, by the development of dermatitis of an edematous and papulovesicular type, chronic skin ulcers, rhinitis, nasopharyngitis, epistaxis, bronchitis and in severe cases, by the development of an acute pneumonitis, with cough, scanty sputum, low-grade fever, rales, dyspnea and substernal pain. Several cases have been reported in which localized granulomatous lesions develop after penetrating wounds caused by splinters of glass from broken fluorescent light tubes. Several weeks or months following the accident, swellings were noted in the injured areas and excision revealed granulomatous tumors, which in one case was shown to contain beryllium. Several cases of beryllium granuloma have been reported in persons residing near processing plants and in families of Be workers.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1): Group B2 - animal carcinogen

Noncarcinogenic Effects
Oral RfD(1): $5x10^{-3}$ mg/kg/day

Carcinogenic Effects
Oral CSF(1): 4.3 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

CADMIUM

INTRODUCTION

Chemical Name:	Cadmium
CAS RN:	7440439
Molecular Formula:	Cd
Molecular Weight:	112.40 g/mole

Cadmium is silver-white, blue-tinged, lustrous metal; easily cut with a knife; available in the form of bars, sheets or wire or a gray granular powder. Cadmium uses are: a constituent of easily fusible alloys; soft solder and solder for aluminum; electroplating, etc.

FATE AND TRANSPORT

BCF(4):	81
Solubility:	Insoluble in water
	Readily soluble in dilute NO_3
	Slowly soluble in hot HCl
Vapor Pressure:	1 mm Hg @ 394°C
Specific Gravity:	8.642

HUMAN HEALTH EFFECTS

Ingestion: (metal and sol compounds): increased salivation, choking, vomiting, abdominal pain, diarrhea, tenesmus.

Inhalation: (dust or fumes): throat dryness, cough, headache, vomiting, chest pain, extreme restlessness and irritability, pneumonitis, possibly bronchopneumonia.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification:	Group D - not classified as a carcinogen
Noncarcinogenic Effects	
Oral RfD(1):	$5x10^{-4}$ mg/kg/day
Carcinogenic Effects	
Inhalation CSF(1):	6.3 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

CHLOROFORM

INTRODUCTION

Chemical Name:	Trichloromethane
CAS RN:	67663
Molecular Formula:	$CHCl_3$
Molecular Weight:	119.37

Colorless liquid, heavy, ethereal odor.

FATE AND TRANSPORT

BCF:(3)	3.75
Solubility:(4)	
Water:	8.22×10^3 mg/L at 20°C
Density:(4)	1.485 g/m^3 (20°C)

HUMAN HEALTH EFFECTS(2)

Chloroform causes irr of the conjunctiva. Upon inhal, it causes dilation of the pupils with reduced reaction to light, as well as reduced intraocular pressure (exper). The material is well known as an anesthetic.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(3):	Group B2 - probable human carcinogen
Noncarcinogenic Effects Oral RfD(1):	1×10^{-2} mg/kg/day
Carcinogenic Effects Oral(1):	6.1×10^{-3} (mg/kg/day)$^{-1}$
Carcinogenic Effects Inhalation CPF(1):	8.05×10^{-2} (mg/kg/day)$^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

3. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

4. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chloroform. Oak Ridge National Laboratory. October 1987.

CHROMIUM

INTRODUCTION

Chemical Name:	Hexavalent Chromium
CAS RN:	7440473
Molecular Formula:	Cr^{+6}
Molecular Weight:	52

Steel gray, lustrous hard metal. Chromium uses include manufacturing of chrome-steel, chrome-nickel-steel allows and chromeplating of metals.

FATE AND TRANSPORT

BCF:	16
Solubility:	Soluble in diluted HCl or H_2SO_4
Specific Gravity:	7-14

HUMAN HEALTH EFFECTS

Chromic acid and its salts have a corrosive action on the skin and mu mem. The lesions are confined to the exposed parts, affecting chiefly the skin of the hands and forearms and the mu mem of the nasal septum. The characteristic lesion is a deep, penetrating ulcer, which, for the most part, does not tend to suppurate, and which is slow in healing.

Small ulcers, about the size of a matchhead or end of a lead pencil, may be found, chiefly around the base of the nails, on the knuckles, dorsum of the hands and forearms. These ulcers tend to be clean and progress slowly. They are frequently painless, even though quite deep. They heal slowly and leave scars.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1):	Group B - human carcinogen by inhalation
Noncarcinogenic Effects	
Oral RfD(1):	$5x10^{-3}$ mg/kg/day
Carcinogenic Effects	
Inhalation CPF(1):	42.0 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

COPPER

INTRODUCTION

Chemical Name:	Copper
CAS RN:	7440508
Molecular Formula:	Cu
Molecular Weight:	63.54 g/mole

Copper exists as a reddish, lustrous, ductile, malleable metal which becomes dull when exposed to air. Uses of copper include brass, copper alloys, electrical conductors, copper salts, art, etc.

FATE AND TRANSPORT

BCF:	200
Solubility:	Water soluble in salt form Soluble in acids and ammonia water
Vapor Pressure:	1 mm Hg @ 1628°C
Specific Gravity:	8.92

HUMAN HEALTH EFFECTS

Copper salts are strong irritants to skin and mucous membranes. Additionally, copper may influence the occurrence of hemochromatosis.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1): Group D - not classified as a carcinogen

Noncarcinogenic Effects
Oral RfD(1): 3.71×10^{-2} mg/kg/day

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand

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4. U.S. EPA. Superfund Public Health Evaluation Manual, Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

1,1-DICHLOROETHENE

INTRODUCTION

Chemical Name:	1,1-Dichloroethene
Synonyms(3):	1,1-Dichloroethylene, Vinylidene dichloride, I,I-DCE
CAS RN:	75354
Molecular Formula:	$C_2H_2Cl_2$
Molecular Weight:	96.94 g/mole

1,1-Dichloroethene is a colorless volatile liquid which exhibits a mild, sweet odor similar to chloroform. Uses of 1,1-dichloroethene include its production as an intermediate while producing vinylidene polymer plastics, i.e. SARAN.

FATE AND TRANSPORT

BCF(4):	5.6
Solubility:	Practically insoluble in water
	Soluble in organic solvents
Density:	1.2129

HUMAN HEALTH EFFECTS

1,1-Dichloroethene has been classified as a probable human carcinogen. In addition this compound is an irritant to skin and mucous membranes. Experimental animals exhibit liver and kidney injury following large doses of this compound.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification:	Group C - probable human carcinogen
Noncarcinogenic Effects	
Oral RfD(1):	9.00×10^{-3} mg/kg/day
Carcinogenic Effects	
Oral CSF(1):	0.600 $(mg/kg/day)^{-1}$
Inhalation CSF(1):	0.175 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

1,4-DICHLOROBENZENE

INTRODUCTION

Chemical Name:	P-Dichlorobenzene
CAS RN:	106467
Molecular Formula:	$C_6H_4Cl_2$
Molecular Weight:	147

1,4-Dichlorobenzene are volatile crystals with a characteristic penetrating odor. Used largely for killing moths and their larvae, roaches, some other insects, peach-tree borers; for preserving furs, woolen cloths, rugs.

FATE AND TRANSPORT

BCF(4):(1)	56
Solubility:(2)	Practically insoluble in water Soluble in alcohol, ether, benzene, chloroform, carbon disulfide
Density:(3)	1.4581 at 20.5°C

HUMAN HEALTH EFFECTS

1,4-Dichlorobenzene has been classified as a probable human carcinogen. Continued exposure to this compound's vapors for months or years may cause headache, nausea, vomiting, weakness, portal cirrhosis, subacute yellow atrophy of liver, cataract, pulmonary granulomatosis, anemia, granulocytopenia. Irritation to skin, eyes, throat also may occur.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification:	Group C - probable human carcinogen
Noncarcinogenic Effects	
Inhalation RfD:(4)	2.29×10^{-1} mg/kg/day
Carcinogenic Effects	
Oral CSF:(5)	2.40×10^{-2} $(mg/kg/day)^{-1}$

REFERENCES

1. U.S. EPA. Superfund Public Health Evaluation Manual, Office of Emergency and Remedial Response, Washington, D.C. October 1986.

2. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

5. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

INDENO(1,2,3)PYRENE

INTRODUCTION

Chemical Name:	Indeno(123-cd)pyrene
CAS RN:	193395
Molecular Formula:	$C_{22}H_{12}$
Molecular Weight:	276.34

HUMAN HEALTH EFFECTS

Ideno(1,2,3-cd)pyrene has been demonstrated to cause increased incidence of epidermoid carcinomas and skin tumors in animal studies. Although there are no human data that specifically link exposure to ideno(1,2,3-cd)pyrene to human cancers, chrysene is a component of mixtures that have been associated with human cancer.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1): Group B-2 - animal carcinogen

Carcinogenic Effects

Oral CSF(1):	2.03 $(mg/kg/day)^{-1}$
Inhalation CSF(2):	1.70 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

LEAD

INTRODUCTION

Chemical Name:	Lead
CAS Number:	7439-92-1
Molecular Formula:	Pb
Molecular Weight:	207.19 g/mole
Chemical Structure:	Pb

Elemental lead is a heavy, ductile, bluish-gray solid at ambient conditions. It is used widely in industry because of its softness, resistance to corrosion and radiation, and high density. Lead is also used as a paint pigment, in solder, and in storage batteries.

FATE AND TRANSPORT

Bioconcentration Factor (BCF):	49
Solubility:	Lead is insoluble in water and organic solvents. It does dissolve in dilute nitric acid(2), and hot, concentrated sulfuric acid(3)
Specific Gravity(2):	11.35 @ 20°C

Lead and lead compounds can be present in air, water, and soil and are extremely persistent in water and soil. Metallic lead and common lead minerals are insoluble in water while manufactured alkyl lead compounds are water soluble.

HUMAN HEALTH EFFECTS

Systemic Effects

Numerous studies have been conducted on the toxic effects of lead. The data present dose effect relationships and are expressed in terms of internal exposure measured in blood lead levels.

Lead affects various systems of the body. The endpoints elicited at low level exposure are neurobehavioral impairment, growth retardation in children, and hypertension in middle-aged men. High exposure levels produce encephalopathy, gastrointestinal effects, anemia, nephropathy, and electrocardiographic abnormalities.

Lead affects the hematopoietic system by interfering with heme biosynthesis and ferrochelatase. This interference results in a reduction of the hemoglobin concentration in blood and an

increase in erythrocyte (red blood cell) destruction. The combination of these two effects produce hypochromic, normocytic anemia with associated reticulocytosis.

Lead exposure also affects the central nervous system. Overt neurological signs have been documented in adults with blood levels ranging as low as 40 to 60 µg/dl. Encephalopathy can occur at blood lead levels of 100 to 200 µg/dl and 80 to 100 µg/dl for adults and children, respectively. As indicated by these levels, children are much more sensitive to neurological effects of lead. Death or irreversible health effects may occur as a result of central nervous system impairment.

A direct relationship has been drawn between blood lead level and children's height, weight, and chest circumference. The strongest relationship was drawn with height. As the blood level increases, the child's growth is retarded(4).

Exposure to lead has significantly effected the human reproductive system. Because lead accumulates in the bones and is sporadically released into the blood, exposure prior to pregnancy may affect the fetus. Blood lead reaches the fetus by crossing through the placental barrier. It was observed in animals that exposure to lead by non-natural routes (e.g., intravenous or intraperitoneal injection) resulted in malformation of the fetus.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(4):	Group B2 - possible human carcinogen
RfD (oral):	Not Available
RfC (inhalation):	Not Available
Cancer Slope Factor (oral, inhalation):	Not Available

REFERENCES

1. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. October 1986.

2. Toxicological Profile for Lead. U.S. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, and U.S. Environmental Protection Agency. Atlanta, Georgia. June 1990.

3. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

4. U.S. Environmental Protection Agency, Federal Register, Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, Vol. 56, No. 110, June 7, 1991.

5. Sax, N.I. and R.J. Lewis. Hazardous Chemical Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

MANGANESE

INTRODUCTION

Chemical Name:	Manganese
CAS Number:	7439-96-5
Molecular Formula:	Mn
Molecular Weight:	54.94 g/mole

Manganese occurs as a brittle silvery metal usually in complex with other metals such as iron. Manganese and its compounds are used in the making of steel alloys, dry-cell batteries, electrical coils, and other metallic fabrication applications. Other manganese uses include use as an oxidizing agent and as a food additive.

FATE AND TRANSPORT

Solubility:

In Water:	Decomposes to ionic forms(1)
In Organics:	Readily dissolves in dilute mineral acids(4)

Specific Gravity: 7.20(1)

HUMAN HEALTH EFFECTS

EPA has established an oral Reference Dose (RfD) for manganese based on central nervous system effects. This oral RfD is based on total dietary intake, and may not be valid if the intake is to occur from drinking water alone.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1): Group D - not classified as a carcinogen

Noncarcinogenic Effects

Oral RfD(1):	5.00×10^{-03} mg/kg/day
Inhalation RfD(1):	1.14×10^{-4} mg/kg/day

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual, Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

NICKEL (Soluble Compounds)

INTRODUCTION

Chemical Name:	Nickel (soluble compounds)
Synonyms(1):	Inorganic nickel salts
CAS Number:	7440020
Molecular Formula:	Ni
Molecular Weight:	58.71 g/mole

Nickel is a silvery-white, hard, malleable and ductile metal. Among nickel's uses are alloys, electrical catalyst for hydrogenation of oils, coins, magnet and electrical contacts.

FATE AND TRANSPORT

Density(3):	8.90
BCF(4):	47
Vapor Pressure(3):	1 mm Hg @ 1810°C

HUMAN HEALTH EFFECTS(5)

Nickel has been found to cause dermatitis while ingestion of soluble nickel salts may cause nausea, vomiting, and diarrhea.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(4):	Group A - classified as human carcinogen

Noncarcinogenic Effects

Oral RfD(2):	$2x10^{-2}$ mg/kg/day

REFERENCES

1. Calabrese, E. and Kenyon, E. Air Toxics and Risk Assessment. Lweis Publishers, Inc. 121 South Main St., Chelsea, Michigan, 48118. 1991.

2. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

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4. U.S. EPA. Superfund Public Health Evaluation Manual, Office of Emergency and Remedial Response, Washington, D.C. October 1986.

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PENTACHLOROPHENOL

INTRODUCTION

Chemical Name:	Pentachlorophenol
Synonyms:	Pentachlorophenate, Thompson's Wood Fix
CAS RN:	87865
Molecular Formula:	C_6HCl_5O
Molecular Weight:	266.32

Pentachlorophenol are dark-colored flakes and sublimed needle crystals which have a pungent odor only when hot. Uses of this compound include preservation of wood, wood products, starches, dextrins, glue and algae control in herbicide formulations.

FATE AND TRANSPORT

Density(3):	1.978
Vapor Pressure(3):	40 mm Hg @ 211.2°
Solubility:	Insoluble in water Very soluble in alcohol Soluble in ether and benzene

HUMAN HEALTH EFFECTS

Pentachlorophenol intake causes an increase then decreases respiration, blood pressure, urinary output, fever, increased bowel action, motor weaknesses, and collapse with and convulsions and death. This compound also causes lung, liver, and kidney damage. It also causes contact dermatitis and may be absorbed through skin. This compound becomes more toxic in organic compounds.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1):	Group B-2 - Probable human carcinogen with sufficient evidence in animals or no evidence in humans
Carcinogenic Effects Oral CSF(1):	0.120 $(mg/kg/day)^{-1}$
NonCarcinogenic Effects Oral RfD(1):	3.00×10^{-2} (mg/kg/day)

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

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4. U.S. EPA. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

POLYCHLORINATED BIPHENYLS
(AROCLOR-1248, aroclor-1254, AROCLOR-1260)

INTRODUCTION

Chemical Name:
CAS RN:

Polychlorinated Biphenyls (PCBs) are chemical mixtures comprised of many isomers and compounds which vary from mobile oily liquids to white crystalline solids and hard noncrystalline resins. PCB uses vary. A major use in the past was as the dielectric in electrical transformer.

FATE AND TRANSPORT

BCF: Not significant

HUMAN HEALTH EFFECTS

PCBs cause chloracne. The chlorinated diphenyls have two distinct actions on the body, namely, a skin effect and a toxic action on the liver. The lesion produced in the liver is an acute yellow atrophy. The higher the chlorine content of the diphenyl compound, the more toxic it may be. Oxides of chlorinated diphenyls are more toxic than the unoxidized materials. The skin lesions known as chloracne consist of small pimples and dark pigmentation of the exposes areas, initially. Later, comedones and pustules develop. In persons who have suffered systematic intoxication, the usual signs and symptoms are nausea, vomiting, loss of weight, jaundice, edema and abdominal pain. Where the liver damage has been severe the patient may pass into coma and die.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1): Group B-2 - animal carcinogen

Carcinogenic Effects
Inhalation CSF(1): 7.70 $(mg/kg/day)^{-1}$

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

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1,1,2,2-TETRACHLOROETHANE

INTRODUCTION

Chemical Name:	1,1,2,2-Tetrachloroethane
CAS RN:	79345
Molecular Formula:	$C_2H_2Cl_4$
Molecular Weight:	167.84

Heavy, colorless, mobile liquid, with a chloroform-like odor.

FATE AND TRANSPORT

Solubility:	Very sparingly soluble in water. Soluble in some organic solvents.

HUMAN HEALTH EFFECTS

1,1,2,2-Tetrachloroethane is considered to be the most toxic of the common chlorinated hydrocarbons. It is an irritant to the mucous membranes of the upper respiratory tract. The toxic action of this compound is on the liver where it produces acute yellow atrophy and cirrhosis. 1,1,2,2-Tetrachloroethane may also have serious effects on the kidneys, heart, brain and central nervous system. It has been observed to increase the incidence of heptocellular carcinoma in mice.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification: Group C - Possible human carcinogen

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. Sax, N.I., and Lewis, P.J. Chemicals Desk Reference. Van-Nostrand Reinhold Company, inc., New York, NY 1987.

3. Strecher, P., et al. The Merck Index. Eighth Edition, Merck and Company, Inc., Rahway, NJ 1968.

TETRACHLOROETHENE

INTRODUCTION

Chemical Name:	Tetrachloroethene
Synonyms:	1,1,2,2-Tetrachloroethylene, Fetrachoroethylene, Perchloroethylene, Perc, Carbon bichloride, Carbon dichloride, ethylene tetrachloride, Per Perchlor, Perchlorethylene, PerK
CAS Number(1):	127184
Molecular Formula:	C_2Cl_4
Molecular Weight:	165.83 g/mole

Tetrachloroethene is a colorless liquid which exhibits an ethereal odor. This compound's former uses included dry cleaning, degreasing metals and solvents.

FATE AND TRANSPORT

Specific Gravity:	1.62
Vapor Pressure(3):	14 mm Hg @ 20°C
Solubility:	Soluble in water
	Miscible with ethanol, diethyl ether and oils
BCF:	31

HUMAN HEALTH EFFECTS

Tetrachloroethene exposure causes irritation, lachrymation and buring of the eyes and irritation of the nose and throat. Exposure may cause vomiting, nausea and drowsiness. Exposures can result in either acute or fatal toxicity. This compound also causes dermatitis with skin blistering and opening of skin. Ingestion of this compound may cause irritation of the gastro intestinal tract resulting in nausea, vomiting, diarrhea and bloody stools.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1):	Group D - not classifiable as to human carcinogenicity
Carcinogenic Effects	
Oral CSF(5):	5.20×10^{-2} (mg/kg/day)$^{-1}$
Inhalation CSF(5):	2.03×10^{-3} (mg/kg/day)$^{-1}$
Noncarcinogenic Effects:	
Oral RfD(1):	1.00×10^{-2} (mg/kg/day)

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

3. Sax, N.I. and R.J. Lewis. Hazardous Chemicals Desk Reference. Van Nostrand Reinhold Company, Inc. New York, New York. 1987.

4. U.S. EPA. Superfund Public Health Evaluation Manual, Office of Emergency and Remedial Response, Washington, D.C. October 1986.

5. USEPA Region III, Setting Exposure Routes And Contaminants Of Concern By Risk-Based Screening, USEPA Region III, Philadelphia, PA, EPA/903/R-93-001, January, 1993.

6. Stecher, P., et. al. The Merck Index. Eighth Edition, Merck & Co., Inc., Rahway, NJ. 1968.

7. Technical Resources, Inc. Toxicological Profile For Tetrachloroethylene, Oak Ridge National Laboratory, December 1987.

TRICHLOROETHENE

INTRODUCTION

Chemical Name:	Trichloroethylene
Synonyms:	Acetylene trichloride, ethylene trichloride, trichloroethene, vestrol
CAS Number(1):	79016
Molecular Formula:	C_2HCl_3
Molecular Weight:	131.40 g/mole

Trichloroethylene is a clear colorless liquid which exhibits an ethereal, chloroform like, sweet odor. This compound's uses include solvent extraction in industries, solvent for fats, coaxes, resins, oils, and paints; degreasing; dry cleaning and manufacture of organic chemicals and pharmaceuticals.

FATE AND TRANSPORT

Specific Gravity:	1.465
Vapor Pressure(3):	59 mm Hg @ 20°C
Solubility:	Soluble in water
	Miscible with many common organic solvents
BCF:	10.6

HUMAN HEALTH EFFECTS

Trichloroethylene is a strong skin and eye irritant. Inhaling high concentrations causes narcosis and anesthesia. Fatal following severe acute exposure by ventricular fibulation resulting in cardiac failure. Liver and other organ damage caused from chronic exposure's suspected but not definitely established.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1):	Group B2 - Probable human carcinogen with sufficient evidence in animals or no evidence in humans.
Carcinogenic Effects	
Oral CSF(2):	1.10×10^{-2} (mg/kg/day)$^{-1}$
Inhalation CSF(5):	6.00×10^{-3} (mg/kg/day)$^{-1}$
Noncarcinogenic Effects:	
Oral RfD(5):	6.00×10^{-3} mg/kg/day

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

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7. Technical Resources, Inc. Toxicological Profile For Tetrachloroethylene. Oak Ridge National Laboratory, December 1987.

VANADIUM

INTRODUCTION

Chemical Name:	Vanadium
CAS Number(1):	7440-62-2
Molecular Formula(1):	V
Molecular Weight(1):	50.94 g/mole

Vanadium is a bright, white, soft ductile metal. Vanadium uses include x-rays, manufacture of alloy steels, catalyst for sulfuric acid and synthetic rubber(1).

FATE AND TRANSPORT

Vanadium is capable of being transported in water systems. The extent of transport is dependant upon the chemical species present and by environmental factors determining its solubility and binding to organic materials.

HUMAN HEALTH EFFECTS

Vanadium has not produced carcinogenic, mutagenic, teratogenic, or reproductive effects in humans or animals. Gastrointestinal distress, nausea, vomiting, abdominal pain, cardiac palpitation, tremor, nervous depression, and kidney damage have been linked with industrial exposure. Oral exposure may produce gastrointestinal disturbances and a greenish-black discoloration of the oral mucosa and tongue. Additionally, studies suggest that the liver, adrenals, and bone marrow may be adversely affected by subacute exposure at high concentrations.

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1):	Group D - not classified as a carcinogen
Noncarcinogenic Effects	
Oral RfD(1):	$3x10^{-1}$ mg/kg/day

REFERENCES

1. IRIS. Integrated Risk Information System. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 1993.

2. HEAST. Health Effects Assessments Summary Tables. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency. FY-1992.

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ZINC

INTRODUCTION

Chemical Name:	Zinc
Synonyms(1):	Zinc dust; Zinc powder
Trade Names(1,2):	Asarco; Blue powder; CI 77945; JASAD; PASCO
CAS Number(1):	7440-66-6
Molecular Formula(1):	Zn
Molecular Weight(1):	65.38 g/mole

Zinc is a shiny white metal with a bluish-gray luster. Among zincs uses are alloys in brass, bronze, and die-casting alloys; galvanizing iron; as a fungicide; and as a protective coating for other metals.

FATE AND TRANSPORT

Density(1):	7.14
Solubility(1):	
In Water:	Insoluble
In Organics:	Soluble in acetic acid and alkali

Zinc has been found to reduce the serum HDL-cholesterol levels in humans following intermediate oral exposure. The decrease in HDL levels may increase risk of coronary artery disease.

Zinc is essential to maintain one's health. However, ingestion of high levels of zinc present a potential for gastrointestinal disorders in humans and animals such as pancreatic abnormalities and gastrointestinal irritation. Biochemical changes (increased serum amylase levels and hypocalcemia) were evident in humans following ingestion of a zinc chloride solution. Animal studies have shown adverse effects including pancreatic fibrosis and degeneration and necrosis of acinar cells of the pancreas. Zinc has also caused internal bleeding in humans and animals following ingestion of high levels.

Hematological effects in humans and animals following high level acute, intermediate or chronic oral exposure to zinc and zinc compounds consist of anemia which can be exacerbated by gastrointestinal bleeding. These effects occur over a wide range of concentrations depending upon the species(1).

No adverse hepatic effects were reported following intermediate oral exposure to zinc in humans. This indicates that the liver is not a primary target organ for zinc toxicity. Hepatic

necrosis was reported in sheep following acute and intermediate exposure, and enzymatic changes were exhibited in rats exposed following intermediate exposure to zinc.

The only renal effects observed were in laboratory animals following intermediate oral exposure to zinc compounds. No adverse renal effects have occurred in humans(1).

SUMMARY OF TOXICOLOGICAL INDICES

EPA Carcinogenic Classification(1):	Group D - not classified as a carcinogen
Noncarcinogenic Effects	
Oral RfD(1):	$3x10^{-1}$ mg/kg/day

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Memorandum to B.Stroud, USEPA Region III, dated September 19, 1994 from J. Dollarhide, Superfund Health Risk Technical Support Center, Oral Systemic and Carcinogenic Toxicity Information.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL CRITERIA AND ASSESSMENT OFFICE
CINCINNATI, OHIO 45268

MEMORANDUM

DATE: September 19, 1994

SUBJECT: Oral Systemic and Carcinogenic Toxicity Information for Cobalt (CASRN 7440-48-4), Iron (CASRN 7439-89-6), Thallium (CASRN 7440-28-0), Dibenzofuran (CASRN 132-64-9) and 2-Methylnaphthalene (CASRN N/A) (USN Naval Amphibious Base/Little Creek/Norfolk, VA)

FROM: Joan S. Dollarhide
Director
Superfund Health Risk Technical Support Center
Chemical Mixtures Assessment Branch

TO: Bob Stroud
U.S. EPA
Region III

This memorandum responds to your request for oral systemic and carcinogenic toxicity information for cobalt, iron, thallium, dibenzofuran and 2-methylnaphthalene for use at the USN Naval Amphibious Base/Little Creek.

Attached please find the following information:

Attachment 1 : Risk Assessment Issue Paper for: Provisional RfD for Cobalt (7440-48-4)

Attachment 2: Risk Assessment Issue Paper for: Evaluation of Carcinogenicity of Cobalt (7740-48-4)

Attachment 3: Risk Assessment Issue Paper for: Derivation of a Provisional RfD for Iron (CASRN 7439-89-6)

Attachment 4: Risk Assessment Issue Paper for: Carcinogenicity of Iron (CASRN 7439-89-6)

Attachment 5: Risk Assessment Issue Paper for: Derivation of a Provisional RfD for Dibenzofuran (CASRN 132-64-9)

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Attachment 1

(92-12/11-18-91)

Risk Assessment Issue Paper for:
Provisional RfD for Cobalt (7440-48-4)

Cobalt has been found to stimulate the production of red blood cells in humans and, therefore, has been used as a treatment for anemia. In 12 anemic, anephric patients undergoing dialysis, treatment with 0.18 mg cobalt/kg/day as cobalt chloride for 12 weeks resulted in a significant rise in hemoglobin (Duckham and Lee, 1976). Taylor et al. (1977) reported similar effects in 8 anephric patients treated with 0.16-0.32 mg cobalt/kg/day as cobalt chloride for 12-32 weeks. In both studies, hemoglobin levels returned to pre-treatment levels following the cessation of treatment. Similar effects were reported in nonanemic humans and animals (Davis and Fields, 1958; Krasovskii and Fridlyand, 1971). Reversible polycythemia was reported in 6 normal male subjects following treatment with 1 mg cobalt/kg/day as cobalt chloride for 25 days (Davis and Fields, 1958). In normal rats, treatment with 0.5 mg cobalt/kg/day, but not 0.05 mg/kg/day, as cobalt chloride resulted in polycythemia and an increase in hemoglobin (Krasovskii and Fridlyand, 1971). An increase in hematocrit and hemoglobin levels was not observed, however, in pregnant women treated with 0.5-0.6 mg cobalt/kg/day for 90 days in an attempt to alleviate the anemia often found during pregnancy (Holly, 1955).

Much of the oral data in humans deals with the cardiomyopathy seen in people who drank large quantities of beer containing cobalt chloride (used to stabilize the foam) (Alexander, 1969, 1972; Morin et al., 1971). The people ingested 0.04-0.14 mg cobalt/kg/day (approximately 8-30 pints of beer daily) over a period of years (Alexander, 1969, 1972; Morin et al., 1971). The cardiomyopathy in the beer-drinkers, termed "beer-cobalt cardiomyopathy", was fatal to 43% of the subjects within several years, with approximately 18% of these deaths occurring within the first several days. The beer-cobalt cardiomyopathy appeared to be similar to alcoholic cardiomyopathy and beriberi, but the onset of the beer-cobalt cardiomyopathy was much more abrupt. The practice of adding cobalt to beer to stabilize the foam has been discontinued. It should be noted, however, that the cardiomyopathy may have also been due to the fact that the beer-drinkers had protein-poor diets and may have had prior cardiac and hepatic damage from alcohol abuse. Treatment of both pregnant and nonpregnant anemic patients with comparable or much higher doses of cobalt (0.09-1 mg cobalt/kg/day) did not result in effects on the heart (Duckham and Lee, 1976; Davis and Fields, 1958; Holly, 1955; Taylor et al., 1977).

Cobalt has been found to be a sensitizer in humans. Individuals are sensitized following dermal or inhalation exposure, but flares of dermatitis may be triggered following cobalt ingestion. One study was located that orally challenged cobalt-exposed workers in order to assess sensitization (Veien et al., 1987). In this study, several patients with eczema of the hands were challenged orally with 1 mg cobalt (0.014 mg cobalt/kg/day as cobalt sulfate) in tablet form once per week for 3 weeks and 28/47 patients had a flare of dermatitis

An alternative approach was likewise evaluated based on the hematological effects of cobalt treatment (increase in hemoglobin) in anemic dialysis patients (Duckham and Lee, 1976). The results of this study are supported by a similar study in anephric patients (Taylor et al., 1977). Hematological effects of cobalt were also found in studies in normal humans (Davis and Fields, 1958) and rats (Krasovskii and Fridlyand, 1971) indicating that the effect is not limited to anephric individuals. The data of Davis and Fields (1958) reported hemoglobin increase of 6-11 % over "normal" in "normal" volunteers given 0.96 mg cobalt/kg/day as cobaltous chloride. However, the data of Duckham and Lee (1976) describes a case of refractory anemia in patients with chronic renal failure that upon treatment with 0.18 mg cobalt/kg/day for 12 weeks responded favorably. The patients hemoglobin levels were increased to levels at or near low "normal" clinical levels from levels clinically described as anemic. The anemia recurred following cessation of treatment. Thus, this effect of cobalt administration in the Duckham and Lee (1976) study (and likewise that of Taylor et al., 1977) cannot be termed adverse, but are actually clinically beneficial to patients with renal disease. Consequently, these data cannot be used to derive an oral RfD.

The only known nutritional, but vital function of cobalt is as a cofactor of vitamin B_{12}. In humans, vitamin B_{12} is derived from bacterial synthesis and therefore, cobalt is essential for animal species, such as ruminants, that depend totally on their bacterial flora for vitamin B_{12}. There is no evidence that the intake of cobalt is ever limiting in the human diet, and therefore no RDA is deemed necessary for cobalt (NRC, 1989). It should be noted that the average daily intake of cobalt in humans ranges from approximately 0.002-0.008 mg cobalt/kg/day in adults (0.16-0.58 mg cobalt/day ÷ 70 kg; Tipton et al., 1966; Schroeder et al., 1967) and 0.01-0.06 mg cobalt/kg/day in children (0.3-1.77 mg cobalt/day ÷ 28 kg; NRC, 1989; Murthy et al., 1971). Murthy et al. (1971) indicated that the children in this study ranged in age from 9-12 years. Using the average weight of 28 kg for children aged 7-10 years (NRC, 1989), the average daily intake for the children in this study ranged from 0.01-0.06 mg/kg/day. If the default adult weight of 70 kg is used with the Murthy data, then the range of intake would be from 0.004-0.025 mg/kg/day.

The effects of chronic occupational exposure to cobalt on the respiratory system are well documented. Cobalt has been found to be the etiologic agent in hard metal disease. The observed effects include respiratory irritation, wheezing, asthma, pneumonia and fibrosis and have been found to occur at exposure levels ranging from 0.003 to 0.893 mg cobalt/m^3 over a period of 2-17 years (Davison et al., 1983; Demedts et al., 1984; Kusaka et al., 1986a,b; Raffn et al., 1988; Shirakawa et al., 1988; Sprince et al., 1988).

Studies have implicated cobalt as a sensitizer in humans. Although the minimum exposure level associated with cobalt sensitization has not been determined, work-related asthma was found in hard metal workers who were occupationally exposed (for greater than 3 years) to levels of cobalt ranging from 0.007 to 0.893 mg cobalt/m^3 (Shirakawa et al., 1988). Given the database, the most sensitive indicators of cobalt toxicity by inhalation exposure are the effects on the respiratory system in both humans and animals and allergic responses in cobalt-sensitized individuals.

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Attachment 2

(92-10b/11-08-91)

Risk Assessment Issue Paper for:
Evaluation of Carcinogenicity of Cobalt (7740-48-4)

CARCINOGENICITY

We have reviewed available data on the potential carcinogenicity of cobalt. Cobalt has been the subject of a very recent Health Effects Assessment document (U.S. EPA, 1991) and an ATSDR (1990) document. In the HEA, stable cobalt and compounds were assigned to EPA group D, not classifiable as to human carcinogenicity (U.S. EPA, 1986). The basis for the classification is the lack of carcinogenicity data in humans or animals by oral exposure and inadequate data in humans and animals by inhalation. The EPA concluded that epidemiological data (Morgan, 1983; Mur et al., 1987) were insufficient to determine the carcinogenic potential of low level occupational exposure to cobalt compounds. In addition, no cobalt-related carcinogenicity was observed in a chronic study with hamsters (Wehner et al., 1977, 1979) or in subchronic inhalations studies in rats and mice (NTP, 1990). Cobalt has been associated with induction of injection site tumors in subcutaneous and intramuscular studies (Heath, 1956; Gilman, 1962; Gilman and Ruckerbauer, 1962; Shabaan et al., 1977), however, extrapolation of these data for estimates of oral and inhalation cancer potency factors were considered inappropriate (U.S. EPA, 1991). The ATSDR document did not provide any additional data. The above mentioned studies have been summarized below, as they appear in the HEA, for your information.

Morgan (1983) investigated the health and causes of death of 49 men occupationally exposed to cobalt salts and oxides in a manufacturing plant in South Wales. During the study period, 33 men died, 5 with lung cancer and 3 with cancer at other sites. The expected number of deaths was 0.3 for lung cancer and 4.1 for all cancers based on national statistics, resulting in SMRs of 167 and 73, respectively. The U.S. EPA (1991) concluded that the scope of this study was too limited to demonstrate the carcinogenicity or noncarcinogenicity of occupational exposure to cobalt compounds.

Mur et al. (1987) analyzed the mortality of a cohort of 1143 workers in a plant that refined and processed cobalt and sodium. An increase in deaths resulting from lung cancer was observed in workers (SMR of 4.66; four cases in the exposed group v.s. 1 case in the controls). In a study within the cohort that controlled for age and smoking habits, 44% (four workers) in the exposed group and 17% (three workers) in the control group died of lung cancer. The authors indicated that the differences were not statistically significant and that the workers were exposed to arsenic and nickel in addition to cobalt. The exposure levels of cobalt were not reported.

Wehner et al. (1977, 1979) exposed groups of 51 month old male Syrian golden hamsters by inhalation to cobalt oxide at 0 or 10 mg/m^3, 7 hours/day, 5 days/week for their

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REVIEW OF PERTINENT LITERATURE

While chronic iron toxicity occurs in people with genetic metabolic disorders resulting in excessive iron absorption, with abnormal hemoglobin synthesis, or who receive frequent blood transfusions (Jacobs, 1977; Bothwell et al., 1979), there is a long-standing controversy as to whether a chronic overload due to oral intake is possible in individuals with a normal ability to control iron absorption (Hillman and Finch, 1985). Nevertheless, "the cumulative experience in human subjects suffering from iron overload of various etiologies strongly suggests that iron is noxious to tissues [when]...present in parenchymal cells...for a sufficiently long period of time" (Bothwell et al., 1979).

Looker et al. (1988) made comparisons of dietary iron intake and biochemical indices of iron status based on values taken from the second National Health and Nutrition Examination Survey (NHANES II) data base. NHANES II was a probability sample of the noninstitutionalized U.S. population aged 6 months to 74 years, conducted between 1976 and 1980 by the National Center for Health Statistics. These data suggest that normal intake of iron by men 16-74 years old exceeds the RDAs, and that iron intake is somewhat lower than the RDA for women younger than 51 years. Concomitant with the study of dietary intake, the NHANES II measured the iron status of these populations. The serum ferritin levels, which index total body iron stores, ranged from 23.8 μg/L, for premenopausal women not using iron supplements, to 105.6 μg/L for 45- to 64-year-old supplement users. These values are well within the normal range of 12-300 μg/L (Cook, 1991). (From Taber's Medical Dictionary, ferritin is the form in which iron is stored in the tissues, principally in the reticuloendothelial cells of the liver, spleen, and bone marrow. [It is] an iron-phosphorus-protein complex containing about 23% iron.) The percent serum transferrin saturation, a measure of the residual capacity of the iron transport system to process potential variations in iron from dietary intake or catabolized body stores, ranged from 23.9% saturation for pre- and post-menopausal women not using iron supplements, to 28.9% saturation for male supplement users in the 25- to 44- and 65- to 75-year-old groups. These values are also within the normal range (20-40%), establishing that the intake levels of 0.15-0.27 mg/kg-day consumed by these groups are both sufficient to protect against iron deficiency and insufficient to cause the toxic effects of iron overload (Elinder, 1986; Cook, 1991; Hillman and Finch, 1985). Therefore, 0.15-0.27 mg/kg-day represents a NOEL for chronic dietary iron intake.

Hemosiderosis (or siderosis) and iron overload are increases in tissue iron or a general increase in iron stores without associated tissue damage (Bothwell et al., 1979; Jacobs, 1977). Hemochromatosis describes massive iron overload (15 g of body iron stores or greater) together with cirrhosis and/or other tissue damage attributable to iron. Although focal deposits of iron may occur in any part of the body where red cells are extravasated, the clinical syndrome of hemochromatosis typically involves damage to the hepatic parenchyma (particularly fibrosis), heart (cardiac dysfunction including failure) and endocrine glands (particularly hypogonadism). Pancreatic iron deposition is common, and massive deposits may be associated with fibrosis and diabetes. A number of studies involving chronic oral administration of iron to animals have been designed in an attempt to identify an animal model for hemochromatosis. Most of these studies have been negative (Bothwell et al., 1979;

Ethiopia reportedly has the highest per capita iron intake in the world, with an average daily intake of 471 mg iron/day (range 98-1418 mg/day; 1.4-20.3 mg iron/kg-day assuming 70 kg body weight) (Roe, 1966; Hofvander, 1968). Increased stored iron in the liver and adverse health effects have not been observed due to low bioavailability of the iron in Ethiopian food.

A recent study in Eastern Finnish men suggests that high serum ferritin concentration and high dietary iron intake are risk factors for myocardial infarction (Salonen et al., 1992). Of the 1,931 randomly selected men aged 42-60 years who had no history of coronary heart disease upon entry to the study, 51 experienced an acute myocardial infarction during the average 3-year follow-up. After adjusting via Cox proportional hazards model for age and examination year, cigarette-pack years, ischemic ECG in exercise test, oxygen uptake, systolic blood pressure, blood glucose, serum copper, blood leukocyte count, and concentrations of serum high density lipoprotein cholesterol, apolipoprotein B, and triglyceride, those having serum ferritin at levels $\geq$ 200 μg/L (median value for healthy adult men is 69-140 μg/L) showed increased risk ($p<0.01$) of myocardial infarction compared to those with lower serum ferritin. Use of the same model and covariates indicated dietary iron intake was also significantly ($p<0.05$) associated with disease risk; consumption of red meat had the strongest correlation of all foods with serum ferritin concentration ($r=0.059$). High serum low density lipoprotein (LDL) cholesterol concentrations ($\geq$5.0 mml/L) associated with elevated serum ferritin was also a strong risk factor for acute myocardial infarction; this lends support to the theory that iron overload elevates risk of acute myocardial infarction by promoting oxidation of LDL (Lauffer, 1991; Sullivan, 1992).

The effects of acute oral exposure to iron in humans are well characterized. Acute iron toxicity has most often been observed in small children who accidentally ingested iron supplements, usually in the form of ferrous sulfate, but also as ferrous gluconate, ferrous chloride, ferric chloride or ferric ammonium citrate (Bothwell et al., 1979). The pathogenesis of acute oral iron toxicity consists primarily of gastrointestinal, cardiovascular, metabolic, neurological and hepatic alterations caused by direct corrosive action or the presence of unbound iron in the circulation (Bothwell et al., 1979; Banner and Tong, 1986; Engle et al., 1987; Mann et al., 1989). Gastrointestinal toxicity is due to the direct caustic effect of iron on the mucosa, particularly in the stomach and small intestine, and is characterized initially by vomiting, diarrhea and abdominal pain. These symptoms can progress to gastric and intestinal hemorrhage and/or necrosis and, rarely, 4-6 weeks after ingestion, scarring that may result in stenosis in the stomach outlet and small intestine. Cardiovascular toxicity of iron results from severe hemodynamic alterations characterized by loss of vascular integrity, decreased circulating plasma volume, decreased cardiac output and acidosis, leading to shock and cardiac failure. Neurological effects ranging from lethargy and mild obtundation to coma may occur. Hepatic damage, which can range from cloudy swelling of hepatocytes to necrosis, is a rare complication after ingestion of large quantities of iron in acute overexposure.

Determinations of serum iron concentration and total iron binding capacity (TIBC) in blood 2-4 hours after ingestion may provide reliable laboratory indices of the bioavailability of iron resulting from an acute ingestion (Mann et al., 1989), but are impractical for

was no statistically significant difference ($p>0.05$) in the development of any of the specific symptoms in any of the groups. The prevalence of symptoms generally increased with increasing serum iron levels, but only 20 of the patients had serum iron levels higher than the concentration of 350 μg/dL, generally considered toxic. Symptoms more serious than gastro-intestinal ones (e.g., metabolic, cardiovascular, central nervous system or hepatic effects) did not develop in any of the patients. The results of this study suggest that acute iron ingestions in the range of 20-60 mg/kg are unlikely to be serious in children. Based on this study, the poison center protocol was changed to home management (i.e., ipecac syrup), for iron ingestions of 20-60 mg/kg unless significant symptoms developed, and hospital referral for ingestions 60 mg/kg or greater.

Effects of iron therapy on the upper gastrointestinal tract were evaluated in 14 healthy volunteers [13 women, 1 man; mean age 29 years (range, 24-48 years)] who were instructed to ingest 325 mg tablets of ferrous sulfate (65 mg iron) 3 times/day (before meals) for 2 weeks (Laine et al., 1988). This study was performed to ascertain whether there is a basis for implications that iron therapy may cause false-positive fecal occult blood testing. Evaluation consisted of gastrointestinal symptom survey, qualitative (Hemoccult) and quantitative (HemoQuant; mg mercury/g stool) testing for fecal blood loss, endoscopy of the upper gastrointestinal tract and histological examination of pinch biopsies of the gastric body, antrum and duodenum. In a separate portion of the study, Hemoccult testing was performed on 13 other subjects [12 men, 1 woman; mean age 33 years (range 23-50 years)] who were similarly treated with ferrous sulfate for 1 week. All subjects served as their own controls and ingested no other substances that could potentially damage the upper gastrointestinal tract during their participation in the study. Based on actual average ingestion of 2.5 tablets/day (2-week study) and 2.6 tablets/day (1-week study) and a reference human body weight of 70 kg (U.S. EPA, 1987), the estimated doses consumed by the subjects were 2.3 and 2.4 mg iron/kg-day, respectively, in addition to dietary iron. All subjects had significantly increased ($p<0.05$) dark brown-black stools and symptoms of nausea and vomiting during the treatment period, but not abdominal pain, compared to the 2 weeks prior to treatment. The stool samples of all 27 subjects were Hemoccult-negative prior to iron treatment. Only 1 of 27 stool samples was questionably trace positive after treatment. Hemoglobin levels in stool did not change significantly after iron treatment. Endoscopic examination showed a significant ($p=0.003$) increase in abnormalities in the stomach, but not duodenum, after therapy. These changes consisted of erythema, small areas of subepithelial hemorrhage and solitary antral erosions in nine, six and two subjects, respectively, and were considered only minimally abnormal. Linear regression analysis showed that there was a significant correlation between endoscopy scores and abdominal pain scores ($r=0.64$, $p=0.01$), but not with vomiting ($r=0.5$, $p=0.07$), diarrhea ($r=0.46$, $p=0.1$) or nausea ($r=0.4$, $p=0.16$). No treatment-related histological changes were observed and there was no correlation between the endoscopic and histologic findings, although the investigators noted that the correlation between endoscopic findings and histologic changes in small mucosal pinch biopsies is "notoriously" poor. Although it was speculated that the changes in the stomach could represent a mild form of iron poisoning, the investigators concluded that the treatment caused mild endoscopic abnormalities of uncertain clinical significance in the stomach. Evidence for iron overload (tissue biopsies or hematologic iron status indices) was not examined.

Nonetheless, it is possible to establish a NOEL for chronic iron overload using the values for dietary intake and iron status indices taken from the second National Health and Nutrition Examination Survey (NHANES II) data base. Looker et al. (1988) made comparisons of dietary iron intake and biochemical indices of iron status using data from NHANES II. The average intakes of iron ranged from 0.15 to 0.27 mg/kg-day. The serum ferritin levels and percent serum transferrin saturation were within the normal range. Thus, intake levels of 0.15-0.27 mg/kg-day consumed are both sufficient to protect against iron deficiency and insufficient to cause the toxic effects of iron overload.

Using the NOAEL of 0.27 (representing the upperbound value in the range of mean dietary iron intakes, dietary plus supplemental, taken from the NHANES II data base) and dividing by an uncertainty factor of 1 yields the provisional chronic oral RfD of 0.3 mg/kg-day. An uncertainty factor of 1 is supported by the fact that iron is an essential element. In addition, the information used to derive the oral RfD for iron was derived from intake data from over 20,000 individuals aged 6 months to 74 years and humans exert an efficient homeostatic control over iron such that body burdens are kept constant with variations in diet.

Confidence in the critical study is high; the NHANES II data are derived from a very large sampling of the U.S. population ranging in age from 6 months to 74 years. Overall confidence in the data base is medium; there are insufficient data to determine what chronic dose level is associated with adverse effects in healthy individuals. While a point estimate has been derived in this risk assessment, individual variations in diet, nutritional status, physiology, etc. suggest that a range of values may be more appropriate. Reflecting the high confidence in the critical study and medium confidence in the data base, confidence in the RfD is medium.

NOTE: This RfD supplies adequate levels of iron to meet the nutritional requirements of adults and adolescents over a lifetime. It does not supply the recommended dietary allowance (RDA) to those members of the population that have greater requirements for a short, less-than-lifetime duration such as infants, pre-adolescent children, and pregnant women. For shorter term requirements for these subpopulations, refer to the RDAs (NAS, 1989). Further, this RfD may not be protective of people with inherited disorders of iron metabolism and could be conservative if applied to exposure scenarios involving forms of iron with low bioavailability.

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Attachment 4

(93-24/07-07-93)

Risk Assessment Issue Paper for:
Carcinogenicity of Iron (CASRN 7439-89-6)

INTRODUCTION

Review documents available for iron and compounds include a Reportable Quantity Document for Carcinogenesis from Iron Dextran (U.S. EPA, 1983), a Health Effects Assessment for Iron and Compounds (U.S. EPA, 1984), and journal articles by Stokinger (1984) and Stevens and Kalkwarf (1990). Iron is not listed on the NTP Chemical Status Report (NTP, 1993a). An NTP Results Report (NTP, 1993b) indicates a gavage study has been completed on iron and compounds, but the study does not meet minimum standards (as per telephone conversation with NTP, April, 1993). The following computer searches, performed in April, 1993, were screened to identify additional pertinent studies not discussed in review documents: TOXLINE (oral and inhalation toxicity and cancer from 1983- April, 1993), CANCERLINE (1990 - April, 1993), MEDLINE (1991 - April, 1993), TSCATS, RTECS, and HSDB.

Iron is not listed on IRIS (U.S. EPA, 1994a), the CRAVE Status Report (U.S. EPA, 1994b), Drinking Water Regulations and Health Advisories (U.S. EPA, 1993b), or Table B (Carcinogenicity) of the HEAST (U.S. EPA, 1993a).

REVIEW OF PERTINENT LITERATURE

Carcinogenicity to humans

Overall, the evidence for carcinogenicity in humans due to iron exposure is inadequate. Studies were located in which iron overload (chronic hemochromatosis) from iron ingestion led to iron deposition in the liver, and eventually to cancer of the liver or other organs. Use of these data for risk assessment, however, is compromised by concurrent use of alcohol or by a congenital abnormality that interfered with the normal regulation of gastrointestinal iron absorption. Negative correlations between iron levels in Norwegian municipal water supplies and cancer morbidity were considered of questionable biological significance. There have been several observations of malignancies in people who had previously received injections of iron dextran complex for iron deficiency, but causality was not established. Evidence for lung cancer in humans occupationally exposed to iron is inadequate due to probable concurrent exposure to other known or potential carcinogens. Several studies have reported an increased risk of cancer in individuals with high body iron stores. An association between increased dietary iron consumption and increased risk of cancer has not been established. Thus, these studies are inadequate for assessing the carcinogenic potential of iron following environmental exposure.

The term hemochromatosis describes massive iron overload (≥15 g of body iron stores) together with cirrhosis of the liver with damage to the hepatic parenchyma (particularly fibrosis) and other organs, including the heart, endocrine glands and pancreas. This condition has been observed in people with idiopathic hemochromatosis, a genetic metabolic disorder resulting in abnormal regulation of gastrointestinal absorption, and hence an excessive bioavailability of orally consumed iron (Jacobs, 1977; Bothwell et al., 1979). Liver cancer, usually hepatocellular carcinoma and less often cholangioma, occurs as a late complication of idiopathic hemochromatosis (Bothwell et al., 1979). Approximately one third of patients with hemochromatosis and cirrhosis develop hepatocellular carcinoma; cancer at other sites is not increased; and early treatment to prevent cirrhosis greatly reduces the risk of death due to cancer (Bonkovsky, 1991). Because it is not possible to associate the prevalence of cancer with iron intake (even were the intake known, the anomalous absorption by these patients would prevent extrapolation to the general population), this phenomenon cannot be used to assess risk of liver cancer from oral iron exposure.

Habitual excessive consumption of home-brewed Kaffer beer brewed in iron vessels led to chronic hemochromatosis among the South African Bantu population (Bothwell and Bradlow, 1960; Bothwell et al., 1964). The low pH (3-3.5) of the beer leached iron from the vessels. Bothwell et al. (1964) estimated, based primarily on drinking habits and analyses of beer samples, that Bantu men consumed a daily average of ≈50-100 mg iron/day from this beer. Assuming a reference body weight of 70 kg, iron intake was 0.7-1.4 mg/kg/day. Assimilation of the iron was facilitated by acidity, the presence of iron-complexing ligands, such as fructose, and the alcohol content of the beer, all of which may have contributed to the bioavailability of the iron (Jacobs, 1977; Finch and Monsen, 1972). Histological examinations of livers taken from 129 male and 18 female Bantu that died from traumatic causes revealed hepatic siderosis in 89% of the livers examined, with the degree of severity increasing with age. Histological examination of the spleen of 50 Bantu also showed siderosis and unspecified histological changes (Bothwell and Bradlow, 1960). In another report, the iron concentration of the liver was assayed. Mean hepatic iron concentrations in 85 male Bantu who died of carcinoma of the esophagus between 1959 and 1964 were significantly above ($p<0.05$) those of males who died of other causes (MacPhail et al., 1979). However, not all of the men with esophageal carcinoma had high hepatic iron concentrations (levels were near normal in 13%). Since alcohol consumption has also been associated with esophageal carcinoma, and the source of excessive Bantu iron intake was home-brewed beer, the esophageal carcinoma may have been due to intake of iron, alcohol or related to other factors such as malnutrition (U.S. EPA, 1984).

IARC (1987) reviewed reports of more than 200 local malignancies in patients receiving iron therapy in the form of intramuscular iron dextran injections. In only one case was a causal relationship considered likely. IARC (1987) regarded these data as inadequate evidence for carcinogenicity of iron dextran in humans. The carcinogenicity of iron dextran has been addressed previously by U.S. EPA (1983).

Flaten and Bolviken (1991) assayed finished drinking water from 384 Norwegian municipal waterworks for >15 inorganic substances, including iron, and correlated the results

The relationship between body iron stores and the risk of cancer was investigated in 174,507 people having a multiphasic health checkup (Selby and Friedman, 1988). Body iron stores were assessed by measuring hemoglobin levels and total iron binding capacity (which is inversely related to body iron stores); the subjects were also questioned regarding recent iron use. It was assumed that iron supplements were used for the treatment of anemia. Statistical adjustments for age and smoking status were made. In men, no significant relationships between the risk for lung cancer or all cancer and recent iron use, hemoglobin levels, or total iron binding capacity were found. In women, significant associations between the risk of lung cancer and the indirect measures of body iron stores were found. For other cancers, the relationships were not statistically significant. Recent iron intake, anemia (hemoglobin < 12 g/dl), and increased total iron binding capacity were associated with lower incidences of lung cancer. This study does not specifically examine the risk of excessive administration of iron or excess body iron stores.

Stevens et al. (1988) examined iron status (as measured by serum transferrin levels and total iron-binding capacity) and cancer risk using data from the 1st National Health and Nutrition Examination Survey (NHANES I). Total iron-binding capacity, transferrin saturation, and serum iron were used to assess body iron stores. After adjustments for age and smoking status, this survey of 8722 adults (included adults who remained alive and cancer-free for 4 years after blood collection) showed decreased total iron-binding capacity and increased incidence of transferrin-saturation level in men who had cancer (n = 242), compared to men who did not (n = 3113). The relationship for women was less clear; among 5367 women of whom 203 had cancer, no association between total iron-binding capacity and risk of cancer was seen. Using a statistical model which controlled for smoking and contained age, race, education, alcohol consumption, and body-mass index variables, an association was found only for women having very high transferrin saturation (≥ 36.7%). For men and women, no significant associations between cancer incidence and hemoglobin or dietary iron intake were found. Transferrin saturation was significantly higher in men with cancer of the esophagus, colon, lung, and bladder, as compared to men without cancer. Men with bladder cancer also had significantly lower total iron binding capacities. When the data were broken down by cancer site, significantly decreased hemoglobin levels were found in men with cancer of the esophagus, pancreas, and prostate, as compared to men without cancer. The decrease in hemoglobin levels may be due to excessive bleeding. In men with colon cancer, a significant increase in dietary iron was observed. This study did not control for confounding factors, such as fat and fiber intakes.

Some support for a connection between increased dietary iron and colorectal cancer was reported by Freudenheim et al. (1990), but other factors may be equally important. When iron intake was adjusted for fat intake, the association between iron intake and cancer incidence was no longer statistically significant. Epidemiology studies by both Freudenheim et al. (1990) and Hoff et al. (1986) found an association between intake of high-fat and low-fiber diet with this form of cancer. Graf and Eaton (1985) found evidence in a Scandinavian study that phytate content (ability of fiber to chelate iron) of fiber may be an important etiological factor; studies in mice support this hypothesis (see Nelson et al., 1989, section on CARCINOGENICITY TO ANIMALS). A case-control study of patients with adenomatous or

is that it was concerned only with respiratory tract carcinogenesis and gave no indication that tissues from sites other than the respiratory tract were examined.

Steinhoff et al. (1991) intratracheally injected Sprague-Dawley rats (50/sex/group) with maximum-tolerated total doses of 390 or 1530 mg/kg of 7 types of iron oxides. Doses of 10-40 mg/kg of Bayferrox 920 (95.8% FeOOH), Bayferrox 130 (96.2% cubic α-Fe_2O_3), Bayferrox 306 (93.1% cubic Fe_3O_4), Bayferrox 1352 (99.2% fibrous α-Fe_2O_3), and AC5031 (96.8% α-Fe_2O_3) were administered every 14 days. The total doses at sacrifice (798 study days) was 1530 mg/kg. Rats received 10 mg/kg doses of RBW 07105/SV2 (87.9% fibrous, magnetic iron oxide doped with 1.85% cobalt) or Bayferrox AC5100M (88.5% fibrous, magnetic iron oxide doped with 2.1% cobalt) every 14 days for 18 treatments and every 4 weeks for the remaining 11 treatments. The total dose received during the 920 day treatment period was 390 mg/kg. At sacrifice, histological examination of organs of the respiratory tract, central nervous system, heart, and abdomen revealed only weak traces of a tumorigenic effect. Two squamous cell carcinomas (questionable whether primary or metastases) in females and 1 histiocytic sarcoma (metastasis; primary tumor unknown) in a male were noted in the groups receiving Bayferrox 1352. Intraperitoneal injection of similar groups of rats with a total dose of 600 mg/kg (200 mg/kg doses at 8 week intervals) of the same iron oxides, followed by sacrifice after 790 or 914 days, yielded slight evidence of tumors in the abdominal cavity with exposure to 5 test substances.

No respiratory tract tumors developed in 20 male or 21 female Syrian hamsters intratracheally injected weekly with 3 mg of ferric oxide dust in saline for 15 weeks (Saffiotti et al., 1968). Controls were 100 animals of each sex. The animals were observed for life, with more than 50% surviving at least 1 year. Survival was reduced in the females, but not the males; the difference was attributed to intercurrent disease. Although the focus of this study was on induction of respiratory tumors, tumors at other sites were also reported; incidences of tumors at other sites were not increased by ferric oxide treatment. It is uncertain whether a maximum tolerated dose was achieved.

There have been numerous reports of injection-site tumors (e.g., sarcomas, histiocytomas and fibromas) in rats, mice or rabbits subcutaneously or intramuscularly administered some iron-carbohydrate complexes (such as iron dextran or saccharated iron oxide), but not others (such as iron-sorbitol-citric acid) (U.S. EPA, 1984; IARC, 1987). Both iron and dextran are essential for the carcinogenicity since intramuscular injections of dextran, iron oxide or iron sulfide alone or intrapleural administration of suspended iron are not tumorigenic in rats (Elinder, 1986). These studies do not necessarily indicate that iron dextran will be carcinogenic to humans, since as noted by IARC (1987), although iron dextran accumulates at an injection site in rodents, it is rapidly dispersed after injection into humans. The risk of carcinogenicity due to iron dextran has been addressed previously by U.S. EPA (1983).

Although no animal studies have conclusively shown iron oxide to be carcinogenic, iron oxide particles are co-carcinogenic in the lungs when administered intratracheally with benzo[a]pyrene or dimethylnitrosamine to hamsters (Creasia and Nettesheim, 1974; Stokinger,

On the basis of inadequate evidence for carcinogenicity in humans and animals, iron is classified in U.S. EPA (1986) weight-of-evidence group D: not classifiable as to human carcinogenicity.

DERIVATION OF ORAL SLOPE FACTOR

According to U.S. EPA (1986) guidelines, classification of a chemical in weight-of-evidence Group D precludes quantitative risk assessment.

DERIVATION OF INHALATION UNIT RISK

According to U.S. EPA (1986) guidelines, classification of a chemical in weight-of-evidence Group D precludes quantitative risk assessment.

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Attachment 5

(93-21/4-12-93)

Risk Assessment Issue Paper for:
Derivation of a Provisional RfD for
Dibenzofuran (CASRN 132-64-9)

We have confirmed that no RfD values are listed for unsubstituted dibenzofuran in IRIS (U.S. EPA, 1994a), the HEAST (U.S. EPA, 1994b), or the RfD Work Group Status Report (U.S. EPA, 1994c). A RQ document (U.S. EPA, 1989a) and a HEA document (U.S. EPA, 1987) were retrieved, but neither document derived an oral RfD. Unsubstituted dibenzofuran is not listed in the Drinking Water Regulations and Health Advisories list (U.S. EPA, 1994d). Also, unsubstituted dibenzofuran has not been selected for toxicology studies by NTP (NTP, 1993a,b). Literature searches of TOXLINE (1981-1993, oral RfD strategy), MEDLINE (1988-1993, CAS No. strategy), RTECS, HSDB and TSCATS were performed and screened in March 1993.

As reviewed in the RQ document, the only long-term toxicity data for unsubstituted dibenzofuran is a 200-day subchronic oral feeding study by Thomas et al. (1940). There are no pertinent chronic, carcinogenicity, or reproductive data on unsubstituted dibenzofuran. Unsubstituted dibenzofuran was not found to be mutagenic in reverse mutation assays, and a 2-year bioassay of a structurally related compound (dibenzo-p-dioxin) did not result in treatment-related increases in tumor incidence. A more extensive toxicity data base exists for the polychlorinated and polybrominated dibenzofurans (PCDFs and PBDFs). However, as noted by the Agency (U.S. EPA, 1986a), the biological activity of various halogenated dibenzofurans varies greatly, so that risk assessment by analogy to any of these more widely studied compounds would not be recommended.

In the 200-day subchronic unsubstituted dibenzofuran oral study by Thomas et al., groups of five female rats (strain not specified) were fed diets containing unsubstituted dibenzofuran at concentrations of 0, 0.025, 0.050, 0.100, 0.200, 0.400, or 0.800%. All unsubstituted dibenzofuran concentrations resulted in a decrease in absolute organ weights and a decrease in body length (but not in body weight). A corresponding decrease in body weight did not occur along with the decrease in body length because treated rats had an unusually large amount of abdominal fat. Concentrations of 0.050% and above resulted in kidney abnormalities with an accumulation of brown granules in the epithelial cells. Slight hyperplasia of the Malpighian bodies in the spleen, as well as irregular dilation of the collecting tubules in the kidneys were observed at concentrations of 0.400% and above. Based upon a reference body weight of 0.350 kg and a food factor of 0.05 for rats (U.S. EPA, 1986b), concentrations of 0.025%, 0.050% and 0.400% correspond to dosages of 12.5, 25 and 200 mg/kg/day. The dose level of 25 mg/kg/day represents a LOAEL based on kidney effects; 12.5 mg/kg/day is the NOAEL.

Using this study, a provisional oral RfD can be calculated as follows:

Due to the limited toxicity data base for unsubstituted dibenzofuran, confidence in the provisional oral RfD would be low.

Please note that this provisional RfD is for unsubstituted dibenzofuran only, not chlorinated dibenzofurans. To estimate risks posed by chlorinated dibenzofurans, one should use the toxic equivalency factor approach described in U.S. EPA (1989b).

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Attachment 6

(93-30/07-30-93)

Risk Assessment Issue Paper for:
Feasibility of RfD Derivation for 2-Methylnaphthalene
(CASRN 91-57-6)

INTRODUCTION

The TOXLINE (1981-1991) and TSCATS data bases were examined in October 1991 to identify literature regarding health effects associated with exposure to 2-methylnaphthalene and 1-methylnaphthalene (as a possible surrogate). Update searches of TOXLINE (1991-1993, CAS number and chemical names strategy, all cites), CANCERLINE (1963-1993, CAS number and chemical names strategy, all cites), TSCATS, RTECS, and HSDB were performed and screened in April 1993.

In addition to the literature searches, IRIS (U.S. EPA, 1994a), the RfD/RfC Monthly Status Report (U.S. EPA, 1994b), the Drinking Water Regulations and Health Advisories list (U.S. EPA, 1994c), the HEAST (U.S. EPA, 1994d), the NTP Chemical Status Reports (NTP, 1993a;b) and the OHEA CARA lists (U.S. EPA, 1991, 1993), were used to identify sources of additional information. The ATSDR (1990) Toxicological Profile for Naphthalene and 2-Methylnaphthalene and a report by Buckpitt and Franklin (1989) were also reviewed for pertinent literature.

The U.S. EPA (1994a) has not derived an RfD for 2-methylnaphthalene, nor is this chemical under consideration by the RfD/RfC Work Group (U.S. EPA, 1994b) or listed on the HEAST (U.S. EPA, 1994d). ATSDR (1990) has not derived MRL values.

REVIEW OF PERTINENT LITERATURE

Data were not located regarding effects in humans or animals following inhalation or oral exposure to 2-methylnaphthalene (or 1-methylnaphthalene). Information regarding the health effects of 2-methylnaphthalene is restricted to examinations of cell damage in the bronchiolar epithelium of mice (Griffin et al., 1981; Rasmussen et al., 1986; Buckpitt and Franklin, 1989; Honda et al., 1990) and rats (Dinsdale and Verschoyle, 1987) given intraperitoneal injections of 2-methylnaphthalene, and to studies of mononucleated giant cell formation and proteinosis in pulmonary alveoli of mice dermally exposed over a period of 30 weeks to a mixture of 1- and 2-methylnaphthalene (Murata et al., 1992).

Because no data on 2-methylnaphthalene that are suitable for derivation of the requested provisional oral RfD were located, use of the toxicity data for naphthalene as a surrogate for 2-methylnaphthalene have been considered. Intraperitoneal injections of either naphthalene, 1-methylnaphthalene or 2-methylnaphthalene caused cell damage in the bronchiolar epithelium of mice (Rasmussen et al., 1986). Naphthalene and 2-methylnaphthalene were about equally toxic, but changes associated with 1-

Oral and inhalation toxicity data for 2-methylnaphthalene are lacking, precluding derivation of a provisional oral RfD for 2-methylnaphthalene. The use of toxicity data for naphthalene as a surrogate for 2-methylnaphthalene was considered, but the uncertainties in such an approach appear to be too great to warrant its adoption.

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Attachment 7

(93-30/07-30-93)

Risk Assessment Issue Paper for
Carcinogenicity of 2-Methylnaphthalene
(CASRN 91-57-6)

INTRODUCTION

The TOXLINE (1981-1991) and TSCATS data bases were examined in October 1991 to identify literature regarding health effects associated with exposure to 2-methylnaphthalene and 1-methylnaphthalene (as a possible surrogate). Update searches of TOXLINE (1991-1993, CAS number and chemical names strategy, all cites), CANCERLINE (1963-1993, CAS number and chemical name strategy, all cites), TSCATS, RTECS, and HSDB were performed and screened in April 1993.

In addition to the literature searches, IRIS (U.S. EPA, 1994a), the RfD/RfC and CRAVE Monthly Status Report (U.S. EPA, 1994b), the Drinking Water Regulations and Health Advisories list (U.S. EPA, 1994c), the HEAST (U.S. EPA, 1994d), the NTP Chemical Status Reports (NTP, 1993a,b) and the OHEA CARA lists (U.S. EPA, 1991, 1993), were used to identify sources of additional information. The ATSDR (1990) Toxicological Profile on Naphthalene and 2-Methylnaphthalene and a paper by Buckpitt and Franklin (1989) were also reviewed for pertinent literature.

The U.S. EPA (1994a) has not derived an oral slope factor or inhalation unit risk for 2-methylnaphthalene, nor is this chemical under consideration by the CRAVE Work Group (U.S. EPA, 1994b) or listed on the HEAST (U.S. EPA, 1994d).

REVIEW OF PERTINENT LITERATURE

Data were not located regarding carcinogenicity in humans or animals following inhalation or oral exposure to 2-methylnaphthalene (or 1-methylnaphthalene).

Cancer data in mice exposed to naphthalene are available, and use of these data for naphthalene as a surrogate for 2-methylnaphthalene was considered. An inhalation toxicity and carcinogenicity bioassay in mice exposed to naphthalene (NTP, 1992) found increased incidences of pulmonary alveolar and bronchiolar adenomas in females but not in males. Treatment-related minimal to mild nonneoplastic lesions were also observed in the nose (chronic inflammation, metaplasia of the nasal epithelium and hyperplasia of the respiratory epithelium) and lungs (inflammation, alveolar epithelial hyperplasia and occasional occurrence of multinucleated giant cells). Similarly, pulmonary alveolar epidermal hyperplasia and proteinosis occurred in female mice treated dermally with a mixture of 1- and 2-methylnaphthalene for 30 weeks (Murata et al., 1992). Tumorigenesis was neither studied nor reported in this study; the exposure duration was insufficient to evaluate potential carcinogenicity.

Hermann, 1981; NTP, 1993b). In vitro exposure of human lymphocytes to metabolically activated 2-methylnaphthalene increased the incidence of chromosome aberrations and sister chromatid exchanges, but the increases, while statistically significant, were judged to be biologically nonsignificant by the investigators (Kulka et al., 1988).

WEIGHT OF EVIDENCE CLASSIFICATION

Data regarding the carcinogenic potential of 2-methylnaphthalene in humans or animals were not located. The uncertainties in using naphthalene cancer data as surrogate for 2-methylnaphthalene appear too great to warrant use of this approach. On the basis of inadequate evidence for carcinogenicity in humans and animals, 2-methylnaphthalene is classified in U.S. EPA (1986) weight-of-evidence group D: not classifiable as to human carcinogenicity.

DERIVATION OF ORAL SLOPE FACTOR AND INHALATION UNIT RISK

According to U.S. EPA (1986) guidelines, classification of a chemical in weight-of-evidence Group D precludes quantitative risk assessment.

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APPENDIX N

Chemicals of Concern

SITE - 7

CONSTITUENTS DETECTED IN SURFACE SOIL SAMPLES
SITE 7
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)	Residential Soil Concentration (ug/kg) [a]	Potential Concern
VOLATILES				
Methylene chloride	1 / 8	6 j	8.50E+03	NO
Acetone	2 / 8	11 – 12	7.80E+05	NO
SEMI–VOLATILES				
2–Methyl naphthalene	1 / 8	62 j		NO
Fluorene	1 / 8	60 j	3.10E+05	NO
Phenanthrene	4 / 8	39 – 830		YES
Anthracene	2 / 8	51 – 220 j	2.30E+06	NO
Fluoranthene	4 / 8	46 – 1300	3.10E+05	NO
Pyrene	6 / 8	52 – 1600	2.30E+05	NO
Butylbenzyl phthalate	1 / 8	58 j	1.60E+06	NO
Benzo (a) anthracene	2 / 8	110 – 710	8.80E+02	NO
Chrysene	2 / 8	82 – 390	8.80E+04	NO
Bis (2) ethylhexphthalate	8 / 8	47 – 190 j	4.60E+03	NO
Benzo (b) fluoranthene	2 / 8	100 – 510	8.80E+02	NO
Benzo (k) fluoranthene	1 / 8	380	8.80E+03	NO
Benzo (a) pyrene	2 / 8	57 – 450	8.80E+01	YES
Indeno (1,2,3–cd)pyrene	1 / 8	230 j	8.80E+02	NO
Benzo (g,h,i) perylene	1 / 8	210 j		NO
PCBs & PESTICIDES				
4,4'–DDT	1 / 8	3.8 j	1.90E+03	NO
Alpha–chlordane	1 / 8	5.1 j	4.90E+02	NO
Aroclor–1260	3 / 8	130 – 3500 j	8.30E+01	YES

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

CONSTITUENTS DETECTED IN SURFACE SOIL SAMPLES
SITE 7
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)	Residential Soil Concentration (ug/kg) [a]	Potential Concern
INORGANICS				
Aluminum	8 / 8	2200000 – 6240000	2.30E+07	YES
Arsenic	8 / 8	860 b – 3500	3.70E+02	YES
Barium	8 / 8	8800 b – 93900	5.50E+05	YES
Beryllium [b]	4 / 8	230 b – 650 b	1.50E+02	YES
Cadmium	2 / 8	650 b – 1400	3.90E+04	YES
Calcium	8 / 8	162000 – 2450000		NO
Chromium	8 / 8	4600 – 26500	3.90E+04	YES
Cobalt [b]	7 / 8	5900 b – 6100 b	4.70E+05	YES
Copper	8 / 8	4500 – 78200 j	2.90E+05	YES
Iron	8 / 8	3040000 – 1E+07 j		YES
Lead	8 / 8	5500 – 638000 j		YES *
Magnesium	8 / 8	251000 – 3210000		NO
Manganese	8 / 8	18100 – 470000 j	3.90E+04	YES
Mercury	1 / 8	70	2.30E+03	NO
Nickel	7 / 8	3400 – 18000	1.60E+05	YES
Potassium	8 / 8	236000 – 2970000 b		NO
Sodium	2 / 8	227000 b – 262000		NO
Vanadium	8 / 8	7400 b – 202000	5.50E+04	YES
Zinc	8 / 8	12600 – 405000	2.30E+06	YES

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum where it is obtained from the January 11, 1994 RBC Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

b. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 7

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E−01	200	1	14	6	1E−06	15	2190	25550	4.24E−07	3.64E−08	2.90E−02	--	1.46E−05	--	0.02%	0.00%
Benzo (a)−pyrene	4.50E−01	200	1	14	6	1E−06	15	2190	25550	2.30E−07	1.97E−08	--	7.30E+00	--	1.44E−07	0.00%	8.39%
Aroclor−1260	3.50E+00	200	1	14	6	1E−06	15	2190	25550	1.79E−06	1.53E−07	--	7.70E+00	--	1.18E−06	0.00%	68.83%
Aluminum	6.24E+03	200	1	14	6	1E−06	15	2190	25550	3.19E−03	2.74E−04	2.90E+00	--	1.10E−03	--	1.17%	0.00%
Arsenic	3.50E+00	200	1	14	6	1E−06	15	2190	25550	1.79E−06	1.53E−07	3.00E−04	1.75E+00	5.97E−03	2.68E−07	6.34%	15.64%
Barium	9.39E+01	200	1	14	6	1E−06	15	2190	25550	4.80E−05	4.12E−06	7.00E−02	--	6.86E−04	--	0.73%	0.00%
Beryllium	6.50E−01	200	1	14	6	1E−06	15	2190	25550	3.32E−07	2.85E−08	5.00E−03	4.30E+00	6.65E−05	1.23E−07	0.07%	7.14%
Cadmium	1.40E+00	200	1	14	6	1E−06	15	2190	25550	7.16E−07	6.14E−08	5.00E−04	--	1.43E−03	--	1.52%	0.00%
Chromium	2.65E+01	200	1	14	6	1E−06	15	2190	25550	1.36E−05	1.16E−06	5.00E−03	--	2.71E−03	--	2.88%	0.00%
Cobalt	6.10E+00	200	1	14	6	1E−06	15	2190	25550	3.12E−06	2.67E−07	6.00E−02	--	5.20E−05	--	0.06%	0.00%
Copper	7.82E+01	200	1	14	6	1E−06	15	2190	25550	4.00E−05	3.43E−06	3.71E−02	--	1.08E−03	--	1.15%	0.00%
Iron	1.00E+04	200	1	14	6	1E−06	15	2190	25550	5.11E−03	4.38E−04	3.00E−01	--	1.70E−02	--	18.11%	0.00%
Manganese	4.70E+02	200	1	14	6	1E−06	15	2190	25550	2.40E−04	2.06E−05	5.00E−03	--	4.81E−02	--	51.07%	0.00%
Nickel	1.80E+01	200	1	14	6	1E−06	15	2190	25550	9.21E−06	7.89E−07	2.00E−02	--	4.60E−04	--	0.49%	0.00%
Vanadium	2.02E+02	200	1	14	6	1E−06	15	2190	25550	1.03E−04	8.85E−06	7.00E−03	--	1.48E−02	--	15.68%	0.00%
Zinc	4.05E+02	200	1	14	6	1E−06	15	2190	25550	2.07E−04	1.78E−05	3.00E−01	--	6.90E−04	--	0.73%	0.00%
TOTAL														9.41E−02	1.72E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 7

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)~1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E-01	100	1	28	30	1E-06	70	10950	25550	9.10E-08	3.90E-08	2.90E-02	--	3.14E-06	--	0.02%	0.00%
Benzo (a)-pyrene	4.50E-01	100	1	28	30	1E-06	70	10950	25550	4.93E-08	2.11E-08	--	7.30E+00	--	1.54E-07	0.00%	8.39%
Aroclor-1260	3.50E+00	100	1	28	30	1E-06	70	10950	25550	3.84E-07	1.64E-07	--	7.70E+00	--	1.27E-06	0.00%	68.83%
Aluminum	6.24E+03	100	1	28	30	1E-06	70	10950	25550	6.84E-04	2.93E-04	2.90E+00	--	2.36E-04	--	1.17%	0.00%
Arsenic	3.50E+00	100	1	28	30	1E-06	70	10950	25550	3.84E-07	1.64E-07	3.00E-04	1.75E+00	1.28E-03	2.88E-07	6.34%	15.64%
Barium	9.39E+01	100	1	28	30	1E-06	70	10950	25550	1.03E-05	4.41E-06	7.00E-02	--	1.47E-04	--	0.73%	0.00%
Beryllium	6.50E-01	100	1	28	30	1E-06	70	10950	25550	7.12E-08	3.05E-08	5.00E-03	4.30E+00	1.42E-05	1.31E-07	0.07%	7.14%
Cadmium	1.40E+00	100	1	28	30	1E-06	70	10950	25550	1.53E-07	6.58E-08	5.00E-04	--	3.07E-04	--	1.52%	0.00%
Chromium	2.65E+01	100	1	28	30	1E-06	70	10950	25550	2.90E-06	1.24E-06	5.00E-03	--	5.81E-04	--	2.88%	0.00%
Cobalt	6.10E+00	100	1	28	30	1E-06	70	10950	25550	6.68E-07	2.86E-07	6.00E-02	--	1.11E-05	--	0.06%	0.00%
Copper	7.82E+01	100	1	28	30	1E-06	70	10950	25550	8.57E-06	3.67E-06	3.71E-02	--	2.31E-04	--	1.15%	0.00%
Iron	1.00E+04	100	1	28	30	1E-06	70	10950	25550	1.10E-03	4.70E-04	3.00E-01	--	3.65E-03	--	18.11%	0.00%
Manganese	4.70E+02	100	1	28	30	1E-06	70	10950	25550	5.15E-05	2.21E-05	5.00E-03	--	1.03E-02	--	51.07%	0.00%
Nickel	1.80E+01	100	1	28	30	1E-06	70	10950	25550	1.97E-06	8.45E-07	2.00E-02	--	9.86E-05	--	0.49%	0.00%
Vanadium	2.02E+02	100	1	28	30	1E-06	70	10950	25550	2.21E-05	9.49E-06	7.00E-03	--	3.16E-03	--	15.68%	0.00%
Zinc	4.05E+02	100	1	28	30	1E-06	70	10950	25550	4.44E-05	1.90E-05	3.00E-01	--	1.48E-04	--	0.73%	0.00%
TOTAL														2.02E-02	1.84E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 7

CURRENT SCENARIO
SOIL – INGESTION
WORKER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)–1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E–01	50	1	250	25	1E–06	70	9125	25550	4.06E–07	1.45E–07	2.90E–02	--	1.40E–05	--	0.02%	0.00%
Benzo (a)–pyrene	4.50E–01	50	1	250	25	1E–06	70	9125	25550	2.20E–07	7.86E–08	--	7.30E+00	--	5.74E–07	0.00%	8.39%
Aroclor–1260	3.50E+00	50	1	250	25	1E–06	70	9125	25550	1.71E–06	6.12E–07	--	7.70E+00	--	4.71E–06	0.00%	68.83%
Aluminum	6.24E+03	50	1	250	25	1E–06	70	9125	25550	3.05E–03	1.09E–03	2.90E+00	--	1.05E–03	--	1.17%	0.00%
Arsenic	3.50E+00	50	1	250	25	1E–06	70	9125	25550	1.71E–06	6.12E–07	3.00E–04	1.75E+00	5.71E–03	1.07E–06	6.34%	15.64%
Barium	9.39E+01	50	1	250	25	1E–06	70	9125	25550	4.59E–05	1.64E–05	7.00E–02	--	6.56E–04	--	0.73%	0.00%
Beryllium	6.50E–01	50	1	250	25	1E–06	70	9125	25550	3.18E–07	1.14E–07	5.00E–03	4.30E+00	6.36E–05	4.88E–07	0.07%	7.14%
Cadmium	1.40E+00	50	1	250	25	1E–06	70	9125	25550	6.85E–07	2.45E–07	5.00E–04	--	1.37E–03	--	1.52%	0.00%
Chromium	2.65E+01	50	1	250	25	1E–06	70	9125	25550	1.30E–05	4.63E–06	5.00E–03	--	2.59E–03	--	2.88%	0.00%
Cobalt	6.10E+00	50	1	250	25	1E–06	70	9125	25550	2.98E–06	1.07E–06	6.00E–02	--	4.97E–05	--	0.06%	0.00%
Copper	7.82E+01	50	1	250	25	1E–06	70	9125	25550	3.83E–05	1.37E–05	3.71E–02	--	1.03E–03	--	1.15%	0.00%
Iron	1.00E+04	50	1	250	25	1E–06	70	9125	25550	4.89E–03	1.75E–03	3.00E–01	--	1.63E–02	--	18.11%	0.00%
Manganese	4.70E+02	50	1	250	25	1E–06	70	9125	25550	2.30E–04	8.21E–05	5.00E–03	--	4.60E–02	--	51.07%	0.00%
Nickel	1.80E+01	50	1	250	25	1E–06	70	9125	25550	8.81E–06	3.15E–06	2.00E–02	--	4.40E–04	--	0.49%	0.00%
Vanadium	2.02E+02	50	1	250	25	1E–06	70	9125	25550	9.88E–05	3.53E–05	7.00E–03	--	1.41E–02	--	15.68%	0.00%
Zinc	4.05E+02	50	1	250	25	1E–06	70	9125	25550	1.98E–04	7.08E–05	3.00E–01	--	6.60E–04	--	0.73%	0.00%
TOTAL														9.01E–02	6.84E–06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 7

CURRENT SCENARIO
SOIL – DERMAL
TRESPASSER CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E-01	1820	1	0.01	14	6	1E-06	15	2190	25550	3.86E-08	3.31E-09	2.90E-02	--	1.33E-06	–	0.16%	0.00%
Benzo (a)-pyrene	4.50E-01	1820	1	0.01	14	6	1E-06	15	2190	25550	2.09E-08	1.80E-09	--	7.30E+00	--	1.31E-08	0.00%	1.98%
Aroclor-1260	3.50E+00	1820	1	0.06	14	6	1E-06	15	2190	25550	9.77E-07	8.38E-08	--	7.70E+00	--	6.45E-07	0.00%	97.48%
Aluminum	6.24E+03	1820	1	0.001	14	6	1E-06	15	2190	25550	2.90E-05	2.49E-06	2.90E+00	--	1.00E-05	–	1.17%	0.00%
Arsenic	3.50E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.63E-08	1.40E-09	3.00E-04	1.75E+00	5.43E-05	2.44E-09	6.33%	0.37%
Barium	9.39E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	4.37E-07	3.75E-08	7.00E-02	--	6.24E-06	–	0.73%	0.00%
Beryllium	6.50E-01	1820	1	0.001	14	6	1E-06	15	2190	25550	3.03E-09	2.59E-10	5.00E-03	4.30E+00	6.05E-07	1.11E-09	0.07%	0.17%
Cadmium	1.40E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	6.52E-09	5.58E-10	5.00E-04	--	1.30E-05	–	1.52%	0.00%
Chromium	2.65E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.23E-07	1.06E-08	5.00E-03	--	2.47E-05	–	2.88%	0.00%
Cobalt	6.10E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	2.84E-08	2.43E-09	6.00E-02	--	4.73E-07	–	0.06%	0.00%
Copper	7.82E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	3.64E-07	3.12E-08	3.71E-02	--	9.81E-06	–	1.14%	0.00%
Iron	1.00E+04	1820	1	0.001	14	6	1E-06	15	2190	25550	4.65E-05	3.99E-06	3.00E-01	--	1.55E-04	–	18.08%	0.00%
Manganese	4.70E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	2.19E-06	1.87E-07	5.00E-03	--	4.37E-04	–	51.00%	0.00%
Nickel	1.80E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	8.38E-08	7.18E-09	2.00E-02	--	4.19E-06	–	0.49%	0.00%
Vanadium	2.02E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	9.40E-07	8.06E-08	7.00E-03	--	1.34E-04	–	15.66%	0.00%
Zinc	4.05E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	1.88E-06	1.62E-07	3.00E-01	--	6.28E-06	–	0.73%	0.00%
TOTAL															8.58E-04	6.62E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 7

CURRENT SCENARIO
SOIL -- DERMAL
TRESPASSER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E-01	5800	1	0.01	28	30	1E-06	70	10950	25550	5.28E-08	2.26E-08	2.90E-02	--	1.82E-06	-	0.16%	0.00%
Benzo (a)-pyrene	4.50E-01	5800	1	0.01	28	30	1E-06	70	10950	25550	2.86E-08	1.23E-08	--	7.30E+00	--	8.95E-08	0.00%	1.98%
Aroclor-1260	3.50E+00	5800	1	0.06	28	30	1E-06	70	10950	25550	1.33E-06	5.72E-07	--	7.70E+00	--	4.40E-06	0.00%	97.48%
Aluminum	6.24E+03	5800	1	0.001	28	30	1E-06	70	10950	25550	3.97E-05	1.70E-05	2.90E+00	--	1.37E-05	-	1.17%	0.00%
Arsenic	3.50E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	2.22E-08	9.53E-09	3.00E-04	1.75E+00	7.42E-05	1.67E-08	6.33%	0.37%
Barium	9.39E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	5.97E-07	2.56E-07	7.00E-02	--	8.53E-06	-	0.73%	0.00%
Beryllium	6.50E-01	5800	1	0.001	28	30	1E-06	70	10950	25550	4.13E-09	1.77E-09	5.00E-03	4.30E+00	8.26E-07	7.61E-09	0.07%	0.17%
Cadmium	1.40E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	8.90E-09	3.81E-09	5.00E-04	--	1.78E-05	-	1.52%	0.00%
Chromium	2.65E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.68E-07	7.22E-08	5.00E-03	--	3.37E-05	-	2.88%	0.00%
Cobalt	6.10E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	3.88E-08	1.66E-08	6.00E-02	--	6.46E-07	-	0.06%	0.00%
Copper	7.82E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	4.97E-07	2.13E-07	3.71E-02	--	1.34E-05	-	1.14%	0.00%
Iron	1.00E+04	5800	1	0.001	28	30	1E-06	70	10950	25550	6.36E-05	2.72E-05	3.00E-01	--	2.12E-04	-	18.08%	0.00%
Manganese	4.70E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	2.99E-06	1.28E-06	5.00E-03	--	5.97E-04	-	51.00%	0.00%
Nickel	1.80E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.14E-07	4.90E-08	2.00E-02	--	5.72E-06	-	0.49%	0.00%
Vanadium	2.02E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	1.28E-06	5.50E-07	7.00E-03	--	1.83E-04	-	15.66%	0.00%
Zinc	4.05E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	2.57E-06	1.10E-06	3.00E-01	--	8.58E-06	-	0.73%	0.00%
TOTAL															1.17E-03	4.52E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 7

CURRENT SCENARIO
SOIL – DERMAL
WORKER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E-01	5800	1	0.01	250	25	1E-06	70	9125	25550	4.71E-07	1.68E-07	2.90E-02	--	1.62E-05	--	0.16%	0.00%
Benzo (a)-pyrene	4.50E-01	5800	1	0.01	250	25	1E-06	70	9125	25550	2.55E-07	9.12E-08	--	7.30E+00	--	6.66E-07	0.00%	1.98%
Aroclor-1260	3.50E+00	5800	1	0.06	250	25	1E-06	70	9125	25550	1.19E-05	4.26E-06	--	7.70E+00	--	3.28E-05	0.00%	97.48%
Aluminum	6.24E+03	5800	1	0.001	250	25	1E-06	70	9125	25550	3.54E-04	1.26E-04	2.90E+00	--	1.22E-04	--	1.17%	0.00%
Arsenic	3.50E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	1.99E-07	7.09E-08	3.00E-04	1.75E+00	6.62E-04	1.24E-07	6.33%	0.37%
Barium	9.39E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	5.33E-06	1.90E-06	7.00E-02	--	7.61E-05	--	0.73%	0.00%
Beryllium	6.50E-01	5800	1	0.001	250	25	1E-06	70	9125	25550	3.69E-08	1.32E-08	5.00E-03	4.30E+00	7.38E-06	5.67E-08	0.07%	0.17%
Cadmium	1.40E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	7.95E-08	2.84E-08	5.00E-04	--	1.59E-04	--	1.52%	0.00%
Chromium	2.65E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	1.50E-06	5.37E-07	5.00E-03	--	3.01E-04	--	2.88%	0.00%
Cobalt	6.10E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	3.46E-07	1.24E-07	6.00E-02	--	5.77E-06	--	0.06%	0.00%
Copper	7.82E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	4.44E-06	1.58E-06	3.71E-02	--	1.20E-04	--	1.14%	0.00%
Iron	1.00E+04	5800	1	0.001	250	25	1E-06	70	9125	25550	5.68E-04	2.03E-04	3.00E-01	--	1.89E-03	--	18.08%	0.00%
Manganese	4.70E+02	5800	1	0.001	250	25	1E-06	70	9125	25550	2.67E-05	9.53E-06	5.00E-03	--	5.33E-03	--	51.00%	0.00%
Nickel	1.80E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	1.02E-06	3.65E-07	2.00E-02	--	5.11E-05	--	0.49%	0.00%
Vanadium	2.02E+02	5800	1	0.001	250	25	1E-06	70	9125	25550	1.15E-05	4.09E-06	7.00E-03	--	1.64E-03	--	15.66%	0.00%
Zinc	4.05E+02	5800	1	0.001	250	25	1E-06	70	9125	25550	2.30E-05	8.21E-06	3.00E-01	--	7.66E-05	--	0.73%	0.00%
TOTAL															1.05E-02	3.36E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 7

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E-01	200	1	350	6	1E-06	15	2190	25550	1.06E-05	9.10E-07	2.90E-02	--	3.66E-04	--	0.02%	0.00%
Benzo (a)-pyrene	4.50E-01	200	1	350	6	1E-06	15	2190	25550	5.75E-06	4.93E-07	--	7.30E+00	--	3.60E-06	0.00%	8.39%
Aroclor-1260	3.50E+00	200	1	350	6	1E-06	15	2190	25550	4.47E-05	3.84E-06	--	7.70E+00	--	2.95E-05	0.00%	68.83%
Aluminum	6.24E+03	200	1	350	6	1E-06	15	2190	25550	7.98E-02	6.84E-03	2.90E+00	--	2.75E-02	--	1.17%	0.00%
Arsenic	3.50E+00	200	1	350	6	1E-06	15	2190	25550	4.47E-05	3.84E-06	3.00E-04	1.75E+00	1.49E-01	6.71E-06	6.34%	15.64%
Barium	9.39E+01	200	1	350	6	1E-06	15	2190	25550	1.20E-03	1.03E-04	7.00E-02	--	1.72E-02	--	0.73%	0.00%
Beryllium	6.50E-01	200	1	350	6	1E-06	15	2190	25550	8.31E-06	7.12E-07	5.00E-03	4.30E+00	1.66E-03	3.06E-06	0.07%	7.14%
Cadmium	1.40E+00	200	1	350	6	1E-06	15	2190	25550	1.79E-05	1.53E-06	5.00E-04	--	3.58E-02	--	1.52%	0.00%
Chromium	2.65E+01	200	1	350	6	1E-06	15	2190	25550	3.39E-04	2.90E-05	5.00E-03	--	6.78E-02	--	2.88%	0.00%
Cobalt	6.10E+00	200	1	350	6	1E-06	15	2190	25550	7.80E-05	6.68E-06	6.00E-02	--	1.30E-03	--	0.06%	0.00%
Copper	7.82E+01	200	1	350	6	1E-06	15	2190	25550	1.00E-03	8.57E-05	3.71E-02	--	2.69E-02	--	1.15%	0.00%
Iron	1.00E+04	200	1	350	6	1E-06	15	2190	25550	1.28E-01	1.10E-02	3.00E-01	--	4.26E-01	--	18.11%	0.00%
Manganese	4.70E+02	200	1	350	6	1E-06	15	2190	25550	6.01E-03	5.15E-04	5.00E-03	--	1.20E+00	--	51.07%	0.00%
Nickel	1.80E+01	200	1	350	6	1E-06	15	2190	25550	2.30E-04	1.97E-05	2.00E-02	--	1.15E-02	--	0.49%	0.00%
Vanadium	2.02E+02	200	1	350	6	1E-06	15	2190	25550	2.58E-03	2.21E-04	7.00E-03	--	3.69E-01	--	15.68%	0.00%
Zinc	4.05E+02	200	1	350	6	1E-06	15	2190	25550	5.18E-03	4.44E-04	3.00E-01	--	1.73E-02	--	0.73%	0.00%
TOTAL														2.35E+00	4.29E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 7

FUTURE SCENARIO
SOIL -- INGESTION
RESIDENT ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E-01	100	1	350	30	1E-06	70	10950	25550	1.14E-06	4.87E-07	2.90E-02	--	3.92E-05	--	0.02%	0.00%
Benzo (a)-pyrene	4.50E-01	100	1	350	30	1E-06	70	10950	25550	6.16E-07	2.64E-07	--	7.30E+00	--	1.93E-06	0.00%	8.39%
Aroclor-1260	3.50E+00	100	1	350	30	1E-06	70	10950	25550	4.79E-06	2.05E-06	--	7.70E+00	--	1.58E-05	0.00%	68.83%
Aluminum	6.24E+03	100	1	350	30	1E-06	70	10950	25550	8.55E-03	3.66E-03	2.90E+00	--	2.95E-03	--	1.17%	0.00%
Arsenic	3.50E+00	100	1	350	30	1E-06	70	10950	25550	4.79E-06	2.05E-06	3.00E-04	1.75E+00	1.60E-02	3.60E-06	6.34%	15.64%
Barium	9.39E+01	100	1	350	30	1E-06	70	10950	25550	1.29E-04	5.51E-05	7.00E-02	--	1.84E-03	--	0.73%	0.00%
Beryllium	6.50E-01	100	1	350	30	1E-06	70	10950	25550	8.90E-07	3.82E-07	5.00E-03	4.30E+00	1.78E-04	1.64E-06	0.07%	7.14%
Cadmium	1.40E+00	100	1	350	30	1E-06	70	10950	25550	1.92E-06	8.22E-07	5.00E-04	--	3.84E-03	--	1.52%	0.00%
Chromium	2.65E+01	100	1	350	30	1E-06	70	10950	25550	3.63E-05	1.56E-05	5.00E-03	--	7.26E-03	--	2.88%	0.00%
Cobalt	6.10E+00	100	1	350	30	1E-06	70	10950	25550	8.36E-06	3.58E-06	6.00E-02	--	1.39E-04	--	0.06%	0.00%
Copper	7.82E+01	100	1	350	30	1E-06	70	10950	25550	1.07E-04	4.59E-05	3.71E-02	--	2.89E-03	--	1.15%	0.00%
Iron	1.00E+04	100	1	350	30	1E-06	70	10950	25550	1.37E-02	5.87E-03	3.00E-01	--	4.57E-02	--	18.11%	0.00%
Manganese	4.70E+02	100	1	350	30	1E-06	70	10950	25550	6.44E-04	2.76E-04	5.00E-03	--	1.29E-01	--	51.07%	0.00%
Nickel	1.80E+01	100	1	350	30	1E-06	70	10950	25550	2.47E-05	1.06E-05	2.00E-02	--	1.23E-03	--	0.49%	0.00%
Vanadium	2.02E+02	100	1	350	30	1E-06	70	10950	25550	2.77E-04	1.19E-04	7.00E-03	--	3.95E-02	--	15.68%	0.00%
Zinc	4.05E+02	100	1	350	30	1E-06	70	10950	25550	5.55E-04	2.38E-04	3.00E-01	--	1.85E-03	--	0.73%	0.00%
TOTAL														2.52E-01	2.30E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 7

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E-01	1820	1	0.01	350	6	1E-06	15	2190	25550	9.66E-07	8.28E-08	2.90E-02	--	3.33E-05	–	0.16%	0.00%
Benzo (a)-pyrene	4.50E-01	1820	1	0.01	350	6	1E-06	15	2190	25550	5.24E-07	4.49E-08	--	7.30E+00	--	3.28E-07	0.00%	1.98%
Aroclor-1260	3.50E+00	1820	1	0.06	350	6	1E-06	15	2190	25550	2.44E-05	2.09E-06	--	7.70E+00	--	1.61E-05	0.00%	97.48%
Aluminum	6.24E+03	1820	1	0.001	350	6	1E-06	15	2190	25550	7.26E-04	6.22E-05	2.90E+00	--	2.50E-04	–	1.17%	0.00%
Arsenic	3.50E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	4.07E-07	3.49E-08	3.00E-04	1.75E+00	1.36E-03	6.11E-08	6.33%	0.37%
Barium	9.39E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	1.09E-05	9.36E-07	7.00E-02	--	1.56E-04	–	0.73%	0.00%
Beryllium	6.50E-01	1820	1	0.001	350	6	1E-06	15	2190	25550	7.56E-08	6.48E-09	5.00E-03	4.30E+00	1.51E-05	2.79E-08	0.07%	0.17%
Cadmium	1.40E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	1.63E-07	1.40E-08	5.00E-04	--	3.26E-04	–	1.52%	0.00%
Chromium	2.65E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	3.08E-06	2.64E-07	5.00E-03	--	6.17E-04	–	2.88%	0.00%
Cobalt	6.10E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	7.10E-07	6.08E-08	6.00E-02	--	1.18E-05	–	0.06%	0.00%
Copper	7.82E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	9.10E-06	7.80E-07	3.71E-02	--	2.45E-04	–	1.14%	0.00%
Iron	1.00E+04	1820	1	0.001	350	6	1E-06	15	2190	25550	1.16E-03	9.97E-05	3.00E-01	--	3.88E-03	–	18.08%	0.00%
Manganese	4.70E+02	1820	1	0.001	350	6	1E-06	15	2190	25550	5.47E-05	4.69E-06	5.00E-03	--	1.09E-02	–	51.00%	0.00%
Nickel	1.80E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	2.09E-06	1.80E-07	2.00E-02	--	1.05E-04	–	0.49%	0.00%
Vanadium	2.02E+02	1820	1	0.001	350	6	1E-06	15	2190	25550	2.35E-05	2.01E-06	7.00E-03	--	3.36E-03	–	15.66%	0.00%
Zinc	4.05E+02	1820	1	0.001	350	6	1E-06	15	2190	25550	4.71E-05	4.04E-06	3.00E-01	--	1.57E-04	–	0.73%	0.00%
TOTAL															2.14E-02	1.65E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 7

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Phenanthrene	8.30E-01	5800	1	0.01	350	30	1E-06	70	10950	25550	6.59E-07	2.83E-07	2.90E-02	--	2.27E-05	–	0.16%	0.00%
Benzo (a)-pyrene	4.50E-01	5800	1	0.01	350	30	1E-06	70	10950	25550	3.58E-07	1.53E-07	--	7.30E+00	--	1.12E-06	0.00%	1.98%
Aroclor-1260	3.50E+00	5800	1	0.06	350	30	1E-06	70	10950	25550	1.67E-05	7.15E-06	--	7.70E+00	--	5.51E-05	0.00%	97.48%
Aluminum	6.24E+03	5800	1	0.001	350	30	1E-06	70	10950	25550	4.96E-04	2.12E-04	2.90E+00	--	1.71E-04	–	1.17%	0.00%
Arsenic	3.50E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	2.78E-07	1.19E-07	3.00E-04	1.75E+00	9.27E-04	2.09E-07	6.33%	0.37%
Barium	9.39E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	7.46E-06	3.20E-06	7.00E-02	--	1.07E-04	–	0.73%	0.00%
Beryllium	6.50E-01	5800	1	0.001	350	30	1E-06	70	10950	25550	5.16E-08	2.21E-08	5.00E-03	4.30E+00	1.03E-05	9.52E-08	0.07%	0.17%
Cadmium	1.40E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	1.11E-07	4.77E-08	5.00E-04	--	2.22E-04	–	1.52%	0.00%
Chromium	2.65E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	2.11E-06	9.02E-07	5.00E-03	--	4.21E-04	–	2.88%	0.00%
Cobalt	6.10E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	4.85E-07	2.08E-07	6.00E-02	--	8.08E-06	–	0.06%	0.00%
Copper	7.82E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	6.21E-06	2.66E-06	3.71E-02	--	1.67E-04	–	1.14%	0.00%
Iron	1.00E+04	5800	1	0.001	350	30	1E-06	70	10950	25550	7.95E-04	3.41E-04	3.00E-01	--	2.65E-03	–	18.08%	0.00%
Manganese	4.70E+02	5800	1	0.001	350	30	1E-06	70	10950	25550	3.73E-05	1.60E-05	5.00E-03	--	7.47E-03	–	51.00%	0.00%
Nickel	1.80E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	1.43E-06	6.13E-07	2.00E-02	--	7.15E-05	–	0.49%	0.00%
Vanadium	2.02E+02	5800	1	0.001	350	30	1E-06	70	10950	25550	1.60E-05	6.88E-06	7.00E-03	--	2.29E-03	–	15.66%	0.00%
Zinc	4.05E+02	5800	1	0.001	350	30	1E-06	70	10950	25550	3.22E-05	1.38E-05	3.00E-01	--	1.07E-04	–	0.73%	0.00%
TOTAL															1.46E-02	5.65E-05	100.00%	100.00%

CONSTITUENTS DETECTED IN SUBSURFACE SOIL SAMPLES
SITE 7
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)	Typical Soil Conc. (ug/kg) [a]	Federal MCL (ug/l) [b]	Tap Water (ug/l) [c]	Health Advisory (ug/l) [d]	Virginia Water Stds. (ug/l) [e]	Potential Concern
VOLATILES								
Methylene chloride	1 / 5	3 j		4.7	4.1			NO
Acetone	2 / 5	56 – 80			370			NO
2–Butanone	1 / 5	9 j						NO
Tetrachloroethene	1 / 5	7 j		0.8	1.1	5	318	NO
SEMI–VOLATILES								
1,4–Dichlorobenzene	1 / 5	38 j		400	0.44	75	400	NO
Bis (2) ethylhexphthalate	1 / 5	100 j		1.8	4.8			NO
INORGANICS								
Aluminum	5 / 5	2E+06 – 1.89E+07	7.10E+07		11000			NO
Arsenic	5 / 5	1300 j – 5.10E+03 j	1.10E+04	0.018	0.038	50	50	NO
Barium	5 / 5	5400 b – 4.61E+04	5.00E+05		260	2000	2000	NO
Beryllium [f]	5 / 5	270 b – 4.40E+02 b	3.00E+02		0.016	4		YES
Cadmium	5 / 5	11000 j – 2.20E+03	5.00E+02		18	5	16	YES
Calcium	5 / 5	218000 – 4.25E+05	2.40E+07					NO
Chromium	5 / 5	4700 – 1.88E+04	1.00E+05		18	100	170	NO
Cobalt [f]	5 / 5	2300 b – 5.10E+03 b	8.00E+03		220			NO
Copper	5 / 5	2600 – 6.90E+03	3.00E+04		140	1300	1300	NO
Iron	5 / 5	4E+06 – 1.30E+07 j	4.00E+07				300	NO
Lead	5 / 5	3500 – 8.40E+03 j	2.90E+04			0	15	NO
Magnesium	5 / 5	636000 – 1.44E+06	5.00E+06					NO
Manganese	5 / 5	17400 – 4.89E+04	1.00E+06		18		50	NO
Mercury	1 / 5	70 b	9.80E+01	0.14	1.1	2	0.144	NO
Nickel	5 / 5	5200 b – 8.90E+03	5.00E+04	610	73	100	607	NO
Potassium	5 / 5	477000 – 9.22E+05	1.40E+07					NO
Sodium	4 / 5	139000 – 1.45E+06	5.00E+06					NO
Vanadium	5 / 5	5300 b – 2.40E+04	1.00E+05		26			NO
Zinc	5 / 5	15500 – 5.80E+04	9.00E+04		1100		5000	NO

Notes:

a. Typical median concentration of inorganics in soils obtained from the following sources:
Bowen, H.J.M., Environmental Chemistry of the Elements. Academic Press, New York, 1979.

Ure, A. M., et. al., "Environmental Constituents of Soils" Environmental Chemistry, Vol. 2, pp94–204 ed H.J.M. Bowen, Royal Society of Chemistry, Burlingtonhouse, London, U.K. 1983.

Parr, James F., Marsh, Paul B., Kla, Joanne M., Land Treatment of Hazardous Wastes, Agricultural Environmental Quality Institute, Agricultural Research Service, OSDA, Beltsville, Maryland, Noyes Data Corporation, Park Ridge, New Jersey, 1983.

Shaklette, H.T. et al., Elemental Composition of Surficial Material in the Conterminous United States, USGS Professions1 Paper 574–D–1971.

b. MCL concentration values represent US Federal Maximum Contaminant Level for potable water supplies.
c. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the January 7, 1994 RBC Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.
d. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."
e. Virginia Water Standards for public water supplies.
f. Constituent concentration is five times greater than the maximum detected in blank (b).

CONSTITUENTS DETECTED IN SUBSURFACE SOIL SAMPLES
SITE 7
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)	Typical Soil Conc. (ug/kg) [a]	Residential Soil Concentration (ug/kg) [b]	Potential Concern
VOLATILES					
Methylene chloride	1 / 5	3 j		8.50E+03	NO
Acetone	2 / 5	56 – 80		7.80E+05	NO
2–Butanone	1 / 5	9 j			NO
Tetrachloroethene	1 / 5	7 j		1.20E+04	NO
SEMI–VOLATILES					
1,4–Dichlorobenzene	1 / 5	38 j		2.70E+04	NO
Bis (2) ethylhexphthalate	1 / 5	100 j			NO
INORGANICS					
Aluminum	5 / 5	2E+06 – 1.89E+07	7.10E+07	2.30E+07	YES
Arsenic	5 / 5	1300 j – 5.10E+03 j	1.10E+04	3.70E+02	YES
Barium	5 / 5	5400 b – 4.61E+04	5.00E+05	5.50E+05	YES
Beryllium [c]	5 / 5	270 b – 4.40E+02 b	3.00E+02	1.50E+02	YES
Cadmium	5 / 5	11000 j – 2.20E+03	5.00E+02	3.90E+04	YES
Calcium	5 / 5	218000 – 4.25E+05	2.40E+07		NO
Chromium	5 / 5	4700 – 1.88E+04	1.00E+05	3.90E+04	YES
Cobalt [c]	5 / 5	2300 b – 5.10E+03 b	8.00E+03	4.70E+05	YES
Copper	5 / 5	2600 – 6.90E+03	3.00E+04	2.90E+05	YES
Iron	5 / 5	4E+06 – 1.30E+07 j	4.00E+07		YES
Lead	5 / 5	3500 – 8.40E+03 j	2.90E+04		YES*
Magnesium	5 / 5	636000 – 1.44E+06	5.00E+06		NO
Manganese	5 / 5	17400 – 4.89E+04	1.00E+06	3.90E+04	YES
Mercury	1 / 5	70 b	9.80E+01	2.30E+03	NO
Nickel	5 / 5	5200 b – 8.90E+03	5.00E+04	1.60E+05	YES
Potassium	5 / 5	477000 – 9.22E+05	1.40E+07		NO
Sodium	4 / 5	139000 – 1.45E+06	5.00E+06		NO
Vanadium	5 / 5	5300 b – 2.40E+04	1.00E+05	5.50E+04	YES
Zinc	5 / 5	15500 – 5.80E+04	9.00E+04	2.30E+06	YES

Notes:

a. Typical median concentration of inorganics in soils obtained from the following sources:
Bowen, H.J.M., Environmental Chemistry of the Elements. Academic Press, New York, 1979.

Ure, A. M., et. al., "Environmental Constituents of Soils" Environmental Chemistry, Vol. 2, pp94–204 ed H.J.M. Bowen, Royal Society of Chemistry, Burlingtonhouse, London, U.K. 1983.

Parr, James F., Marsh, Paul B., Kla, Joanne M., Land Treatment of Hazardous Wastes, Agricultural Environmental Quality Institute, Agricultural Research Service, OSDA, Beltsville, Maryland, Noyes Data Corporation, Park Ridge, New Jersey, 1983.

Shaklette, H.T. et al., Elemental Composition of Surficial Material in the Conterminous United States, USGS Professions1 Paper 574–D–1971.

b. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum where it is obtained from the January 11, 1994 RBC Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

c. Constituent concentration is five times greater than the maximum detected in blank (b).

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SUBSURFACE SOIL
SITE 7

FUTURE SCENARIO
SUBSURFACE SOIL – INGESTION
RESIDENT CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.89E+04	200	1	350	6	1E−06	15	2190	25550	2.42E−01	2.07E−02	2.90E+00	--	8.33E−02	--	7.25%	0.00%
Arsenic	5.10E+00	200	1	350	6	1E−06	15	2190	25550	6.52E−05	5.59E−06	3.00E−04	1.75E+00	2.17E−01	9.78E−06	18.92%	82.51%
Barium	4.61E+01	200	1	350	6	1E−06	15	2190	25550	5.89E−04	5.05E−05	7.00E−02	--	8.42E−03	--	0.73%	0.00%
Beryllium	4.40E−01	200	1	350	6	1E−06	15	2190	25550	5.63E−06	4.82E−07	5.00E−03	4.30E+00	1.13E−03	2.07E−06	0.10%	17.49%
Cadmium	2.20E+00	200	1	350	6	1E−06	15	2190	25550	2.81E−05	2.41E−06	5.00E−04	--	5.63E−02	--	4.90%	0.00%
Chromium	1.88E+01	200	1	350	6	1E−06	15	2190	25550	2.40E−04	2.06E−05	5.00E−03	--	4.81E−02	--	4.18%	0.00%
Cobalt	5.10E+00	200	1	350	6	1E−06	15	2190	25550	6.52E−05	5.59E−06	6.00E−02	--	1.09E−03	--	0.09%	0.00%
Copper	6.90E+00	200	1	350	6	1E−06	15	2190	25550	8.82E−05	7.56E−06	3.71E−02	--	2.38E−03	--	0.21%	0.00%
Iron	1.30E+04	200	1	350	6	1E−06	15	2190	25550	1.66E−01	1.42E−02	3.00E−01	--	5.54E−01	--	48.22%	0.00%
Manganese	4.89E+01	200	1	350	6	1E−06	15	2190	25550	6.25E−04	5.36E−05	5.00E−03	--	1.25E−01	--	10.88%	0.00%
Nickel	8.90E+00	200	1	350	6	1E−06	15	2190	25550	1.14E−04	9.75E−06	2.00E−02	--	5.69E−03	--	0.50%	0.00%
Vanadium	2.40E+01	200	1	350	6	1E−06	15	2190	25550	3.07E−04	2.63E−05	7.00E−03	--	4.38E−02	--	3.81%	0.00%
Zinc	5.80E+01	200	1	350	6	1E−06	15	2190	25550	7.42E−04	6.36E−05	3.00E−01	--	2.47E−03	--	0.22%	0.00%
TOTAL														1.15E+00	1.19E−05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SUBSURFACE SOIL
SITE 7

FUTURE SCENARIO
SUBSURFACE SOIL – INGESTION
RESIDENT ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.89E+04	100	1	350	30	1E−06	70	10950	25550	2.59E−02	1.11E−02	2.90E+00	--	8.93E−03	--	7.25%	0.00%
Arsenic	5.10E+00	100	1	350	30	1E−06	70	10950	25550	6.99E−06	2.99E−06	3.00E−04	1.75E+00	2.33E−02	5.24E−06	18.92%	82.51%
Barium	4.61E+01	100	1	350	30	1E−06	70	10950	25550	6.32E−05	2.71E−05	7.00E−02	--	9.02E−04	--	0.73%	0.00%
Beryllium	4.40E−01	100	1	350	30	1E−06	70	10950	25550	6.03E−07	2.58E−07	5.00E−03	4.30E+00	1.21E−04	1.11E−06	0.10%	17.49%
Cadmium	2.20E+00	100	1	350	30	1E−06	70	10950	25550	3.01E−06	1.29E−06	5.00E−04	--	6.03E−03	--	4.90%	0.00%
Chromium	1.88E+01	100	1	350	30	1E−06	70	10950	25550	2.58E−05	1.10E−05	5.00E−03	--	5.15E−03	--	4.18%	0.00%
Cobalt	5.10E+00	100	1	350	30	1E−06	70	10950	25550	6.99E−06	2.99E−06	6.00E−02	--	1.16E−04	--	0.09%	0.00%
Copper	6.90E+00	100	1	350	30	1E−06	70	10950	25550	9.45E−06	4.05E−06	3.71E−02	--	2.55E−04	--	0.21%	0.00%
Iron	1.30E+04	100	1	350	30	1E−06	70	10950	25550	1.78E−02	7.63E−03	3.00E−01	--	5.94E−02	--	48.22%	0.00%
Manganese	4.69E+01	100	1	350	30	1E−06	70	10950	25550	6.70E−05	2.87E−05	5.00E−03	--	1.34E−02	--	10.88%	0.00%
Nickel	8.90E+00	100	1	350	30	1E−06	70	10950	25550	1.22E−05	5.23E−06	2.00E−02	--	6.10E−04	--	0.50%	0.00%
Vanadium	2.40E+01	100	1	350	30	1E−06	70	10950	25550	3.29E−05	1.41E−05	7.00E−03	--	4.70E−03	--	3.81%	0.00%
Zinc	5.80E+01	100	1	350	30	1E−06	70	10950	25550	7.95E−05	3.41E−05	3.00E−01	--	2.65E−04	--	0.22%	0.00%
TOTAL														1.23E−01	6.35E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SUBSURFACE SOIL
SITE 7

FUTURE SCENARIO
SUBSURFACE SOIL – DERMAL
RESIDENT CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.89E+04	1820	1	0.001	350	6	1E-06	15	2190	25550	2.20E-03	1.88E-04	2.90E+00	--	7.58E-04	–	7.25%	0.00%
Arsenic	5.10E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	5.93E-07	5.09E-08	3.00E-04	1.75E+00	1.98E-03	8.90E-08	18.92%	82.51%
Barium	4.61E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	5.36E-06	4.60E-07	7.00E-02	--	7.66E-05	–	0.73%	0.00%
Beryllium	4.40E-01	1820	1	0.001	350	6	1E-06	15	2190	25550	5.12E-08	4.39E-09	5.00E-03	4.30E+00	1.02E-05	1.89E-08	0.10%	17.49%
Cadmium	2.20E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	2.56E-07	2.19E-08	5.00E-04	--	5.12E-04	–	4.90%	0.00%
Chromium	1.88E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	2.19E-06	1.87E-07	5.00E-03	--	4.37E-04	–	4.18%	0.00%
Cobalt	5.10E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	5.93E-07	5.09E-08	6.00E-02	--	9.89E-06	–	0.09%	0.00%
Copper	6.90E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	8.03E-07	6.88E-08	3.71E-02	--	2.16E-05	–	0.21%	0.00%
Iron	1.30E+04	1820	1	0.001	350	6	1E-06	15	2190	25550	1.51E-03	1.30E-04	3.00E-01	--	5.04E-03	–	48.22%	0.00%
Manganese	4.89E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	5.69E-06	4.88E-07	5.00E-03	--	1.14E-03	–	10.88%	0.00%
Nickel	8.90E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	1.04E-06	8.88E-08	2.00E-02	--	5.18E-05	–	0.50%	0.00%
Vanadium	2.40E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	2.79E-06	2.39E-07	7.00E-03	--	3.99E-04	–	3.81%	0.00%
Zinc	5.80E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	6.75E-06	5.78E-07	3.00E-01	--	2.25E-05	–	0.22%	0.00%
TOTAL															1.05E-02	1.08E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SUBSURFACE SOIL
SITE 7

FUTURE SCENARIO
SUBSURFACE SOIL – DERMAL
RESIDENT ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.89E+04	5800	1	0.001	350	30	1E-06	70	10950	25550	1.50E-03	6.44E-04	2.90E+00	--	5.18E-04	--	7.25%	0.00%
Arsenic	5.10E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	4.05E-07	1.74E-07	3.00E-04	1.75E+00	1.35E-03	3.04E-07	18.92%	82.51%
Barium	4.61E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	3.66E-06	1.57E-06	7.00E-02	--	5.23E-05	--	0.73%	0.00%
Beryllium	4.40E-01	5800	1	0.001	350	30	1E-06	70	10950	25550	3.50E-08	1.50E-08	5.00E-03	4.30E+00	6.99E-06	6.44E-08	0.10%	17.49%
Cadmium	2.20E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	1.75E-07	7.49E-08	5.00E-04	--	3.50E-04	--	4.90%	0.00%
Chromium	1.88E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	1.49E-06	6.40E-07	5.00E-03	--	2.99E-04	--	4.18%	0.00%
Cobalt	5.10E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	4.05E-07	1.74E-07	6.00E-02	--	6.75E-06	--	0.09%	0.00%
Copper	6.90E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	5.48E-07	2.35E-07	3.71E-02	--	1.48E-05	--	0.21%	0.00%
Iron	1.30E+04	5800	1	0.001	350	30	1E-06	70	10950	25550	1.03E-03	4.43E-04	3.00E-01	--	3.44E-03	--	48.22%	0.00%
Manganese	4.89E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	3.89E-06	1.67E-06	5.00E-03	--	7.77E-04	--	10.88%	0.00%
Nickel	8.90E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	7.07E-07	3.03E-07	2.00E-02	--	3.54E-05	--	0.50%	0.00%
Vanadium	2.40E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	1.91E-06	8.17E-07	7.00E-03	--	2.72E-04	--	3.81%	0.00%
Zinc	5.80E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	4.61E-06	1.97E-06	3.00E-01	--	1.54E-05	--	0.22%	0.00%
TOTAL															7.14E-03	3.68E-07	100.00%	100.00%

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 7
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)	Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
VOLATILES							
Acetone	1 / 9	8.0 j		370			NO
INORGANICS							
Aluminum	9 / 9	117 – 330000.0 j		11000			YES
Arsenic	5 / 9	7.8 – 50.6	0.018	0.038	50	50	YES
Barium	9 / 9	33.7 b – 754.0		260	2000	1000	YES
Beryllium	3 / 9	1.9 b – 11.0		0.016	4		YES
Cadmium	3 / 9	4.4 b – 37.6		18	5	0.4	YES
Calcium	9 / 9	7960.0 – 283000.0					NO
Chromium	4 / 9	5.9 – 360.0		18	100	50	YES
Cobalt	5 / 9	3.8 b – 121.0		220			YES
Copper	7 / 9	4.7 b – 226.0		140	1300	1000	YES
Iron	9 / 9	1720 – 224000.0 j					YES
Lead	6 / 9	4.3 – 177.0 j				50	YES *
Magnesium	9 / 9	8340.0 – 596000.0					NO
Manganese	9 / 9	114.0 – 1930.0		18			NO
Mercury	2 / 9	0.18 b – 0.27	0.14	1.1	2	0.05	NO
Nickel	2 / 9	35.7 b – 176.0	610	73	100		YES
Potassium	9 / 9	7810 – 220000.0 j					NO
Sodium	9 / 9	50000.0 – 5.4E+06				270000	NO
Vanadium	3 / 9	43.2 b – 634.0		26			YES
Zinc	4 / 9	37.7 – 1620.0		1100		50	YES
ANIONS							
Alkalinity	9 / 9	16500.0 – 980000.0				30000	YES
Bicarbonate alkalinity	9 / 9	16500.0 – 980000.0					YES
Chloride	9 / 9	49200.0 – 4.65E+07				50000	YES
Sulfate	8 / 9	18500.0 – 1.32E+06				50000	YES

Notes:

a. Federal MCL concentration values represent US Federal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk-Based Concentration Table except for aluminum which is obtained from the Januray 7, 1994 RBC Table using a target hazard quotient of 0.1.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 7

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	3.30E+05	1	14	6	1E−03	15	2190	25550	8.44E−01	7.23E−02	2.90E+00	--	2.91E−01	--	8.74%	0.00%
Arsenic	5.06E+01	1	14	6	1E−03	15	2190	25550	1.29E−04	1.11E−05	3.00E−04	1.75E+00	4.31E−01	1.94E−05	12.95%	65.18%
Barium	7.54E+02	1	14	6	1E−03	15	2190	25550	1.93E−03	1.65E−04	7.00E−02	--	2.75E−02	--	0.83%	0.00%
Beryllium	1.10E+01	1	14	6	1E−03	15	2190	25550	2.81E−05	2.41E−06	5.00E−03	4.30E+00	5.63E−03	1.04E−05	0.17%	34.82%
Cadmium	3.76E+01	1	14	6	1E−03	15	2190	25550	9.61E−05	8.24E−06	5.00E−04	--	1.92E−01	--	5.77%	0.00%
Chromium	3.60E+02	1	14	6	1E−03	15	2190	25550	9.21E−04	7.89E−05	5.00E−03	--	1.84E−01	--	5.53%	0.00%
Cobalt	1.21E+02	1	14	6	1E−03	15	2190	25550	3.09E−04	2.65E−05	6.00E−02	--	5.16E−03	--	0.15%	0.00%
Copper	2.26E+02	1	14	6	1E−03	15	2190	25550	5.78E−04	4.95E−05	3.71E−02	--	1.56E−02	--	0.47%	0.00%
Iron	2.24E+05	1	14	6	1E−03	15	2190	25550	5.73E−01	4.91E−02	3.00E−01	--	1.91E+00	--	57.34%	0.00%
Nickel	1.76E+02	1	14	6	1E−03	15	2190	25550	4.50E−04	3.86E−05	2.00E−02	--	2.25E−02	--	0.68%	0.00%
Vanadium	6.34E+02	1	14	6	1E−03	15	2190	25550	1.62E−03	1.39E−04	7.00E−03	--	2.32E−01	--	6.96%	0.00%
Zinc	1.62E+03	1	14	6	1E−03	15	2190	25550	4.14E−03	3.55E−04	3.00E−01	--	1.38E−02	--	0.41%	0.00%
TOTAL													3.33E+00	2.98E−05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 7

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	3.30E+05	2	28	30	1E−06	70	10950	25550	7.23E−04	3.10E−04	2.90E+00	--	2.49E−04	--	8.74%	0.00%
Arsenic	5.06E+01	2	28	30	1E−06	70	10950	25550	1.11E−07	4.75E−08	3.00E−04	1.75E+00	3.70E−04	8.32E−08	12.95%	65.18%
Barium	7.54E+02	2	28	30	1E−06	70	10950	25550	1.65E−06	7.08E−07	7.00E−02	--	2.36E−05	--	0.83%	0.00%
Beryllium	1.10E+01	2	28	30	1E−06	70	10950	25550	2.41E−08	1.03E−08	5.00E−03	4.30E+00	4.82E−06	4.44E−08	0.17%	34.82%
Cadmium	3.76E+01	2	28	30	1E−06	70	10950	25550	8.24E−08	3.53E−08	5.00E−04	--	1.65E−04	--	5.77%	0.00%
Chromium	3.60E+02	2	28	30	1E−06	70	10950	25550	7.89E−07	3.38E−07	5.00E−03	--	1.58E−04	--	5.53%	0.00%
Cobalt	1.21E+02	2	28	30	1E−06	70	10950	25550	2.65E−07	1.14E−07	6.00E−02	--	4.42E−06	--	0.15%	0.00%
Copper	2.26E+02	2	28	30	1E−06	70	10950	25550	4.95E−07	2.12E−07	3.71E−02	--	1.34E−05	--	0.47%	0.00%
Iron	2.24E+05	2	28	30	1E−06	70	10950	25550	4.91E−04	2.10E−04	3.00E−01	--	1.64E−03	--	57.34%	0.00%
Nickel	1.76E+02	2	28	30	1E−06	70	10950	25550	3.86E−07	1.65E−07	2.00E−02	--	1.93E−05	--	0.68%	0.00%
Vanadium	6.34E+02	2	28	30	1E−06	70	10950	25550	1.39E−06	5.96E−07	7.00E−03	--	1.99E−04	--	6.96%	0.00%
Zinc	1.62E+03	2	28	30	1E−06	70	10950	25550	3.55E−06	1.52E−06	3.00E−01	--	1.18E−05	--	0.41%	0.00%
TOTAL													2.85E−03	1.28E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 7

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	3.30E+05	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	6.14E-03	5.27E-04	2.90E+00	--	2.12E-03	–	8.75%	0.00%
Arsenic	5.06E+01	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	9.42E-07	8.07E-08	3.00E-04	1.75E+00	3.14E-03	1.41E-07	12.97%	65.18%
Barium	7.54E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	1.40E-05	1.20E-06	7.00E-02	--	2.01E-04	–	0.83%	0.00%
Beryllium	1.10E+01	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	2.05E-07	1.76E-08	5.00E-03	4.30E+00	4.10E-05	7.55E-08	0.17%	34.82%
Cadmium	3.76E+01	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	7.00E-07	6.00E-08	5.00E-04	--	1.40E-03	–	5.78%	0.00%
Chromium	3.60E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	6.70E-06	5.74E-07	5.00E-03	--	1.34E-03	–	5.54%	0.00%
Cobalt	1.21E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	2.25E-06	1.93E-07	6.00E-02	--	3.75E-05	–	0.16%	0.00%
Copper	2.26E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	4.21E-06	3.61E-07	3.71E-02	--	1.13E-04	–	0.47%	0.00%
Iron	2.24E+05	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	4.17E-03	3.57E-04	3.00E-01	--	1.39E-02	–	57.44%	0.00%
Nickel	1.76E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	3.28E-06	2.81E-07	2.00E-02	--	1.64E-04	–	0.68%	0.00%
Vanadium	6.34E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	1.18E-05	1.01E-06	7.00E-03	--	1.69E-03	–	6.97%	0.00%
Zinc	1.62E+03	7280	0.0006 *	0.2	14	6	1E-06	15	2190	25550	1.81E-05	1.55E-06	3.00E-01	--	6.03E-05	–	0.25%	0.00%
TOTAL															2.42E-02	2.17E-07	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 7

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	3.30E+05	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	8.32E-03	3.56E-03	2.90E+00	--	2.87E-03	-	8.75%	0.00%
Arsenic	5.06E+01	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	1.28E-06	5.47E-07	3.00E-04	1.75E+00	4.25E-03	9.57E-07	12.97%	65.18%
Barium	7.54E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	1.90E-05	8.14E-06	7.00E-02	--	2.71E-04	-	0.83%	0.00%
Beryllium	1.10E+01	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	2.77E-07	1.19E-07	5.00E-03	4.30E+00	5.55E-05	5.11E-07	0.17%	34.82%
Cadmium	3.76E+01	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	9.48E-07	4.06E-07	5.00E-04	--	1.90E-03	-	5.78%	0.00%
Chromium	3.60E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	9.07E-06	3.89E-06	5.00E-03	--	1.81E-03	-	5.54%	0.00%
Cobalt	1.21E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	3.05E-06	1.31E-06	6.00E-02	--	5.08E-05	-	0.16%	0.00%
Copper	2.26E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	5.70E-06	2.44E-06	3.71E-02	--	1.54E-04	-	0.47%	0.00%
Iron	2.24E+05	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	5.65E-03	2.42E-03	3.00E-01	--	1.88E-02	-	57.44%	0.00%
Nickel	1.76E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	4.44E-06	1.90E-06	2.00E-02	--	2.22E-04	-	0.68%	0.00%
Vanadium	6.34E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	1.60E-05	6.85E-06	7.00E-03	--	2.28E-03	-	6.97%	0.00%
Zinc	1.62E+03	23000	0.0006 *	0.2	28	30	1E-06	70	10950	25550	2.45E-05	1.05E-05	3.00E-01	--	8.17E-05	-	0.25%	0.00%
TOTAL															3.28E-02	1.47E-06	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 7
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)	Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
TOTAL DISSOLVE METALS							
INORGANICS							
Aluminum	2 / 9	19.2 – 272.0 j		11000			YES
Arsenic	4 / 9	2.5t – 16.1	0.018	0.038	50	50	YES
Barium [e]	9 / 9	8.1 b – 101.0 b		260	2000	1000	YES
Beryllium	1 / 9	1.1 b		0.016	4		YES
Calcium	9 / 9	6250.0 – 288000.0					NO
Cobalt [e]	3 / 9	3.5 b – 24.6 b		220			YES
Copper [e]	5 / 9	2.1 b – 8.3 b		140	1300	1000	YES
Iron	6 / 9	605.0 – 38300.0 j					YES
Magnesium	9 / 9	7110.0 – 520000.0					NO
Manganese	9 / 9	46.2 – 1070.0		18			NO
Mercury [e]	2 / 9	0.15 b – 0.15 b	0.14	1.1	2	0.05	YES
Potassium	9 / 9	6770.0 – 192000.0					NO
Sodium	9 / 9	54700.0 – 4.7E+06				270000	NO
Zinc	2 / 9	34.9 – 307.0		1100		50	YES

Notes:

a. Federal MCL concentration values represent US Federal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the Januray 7, 1994 RBC Table using a target hazard quotient of 0.1.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

e. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 7

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
TOTAL DISSOLVE METALS																
Aluminum	2.72E+02	1	14	6	1E-03	15	2190	25550	6.96E-04	5.96E-05	2.90E+00	--	2.40E-04	--	0.05%	0.00%
Arsenic	1.61E+01	1	14	6	1E-03	15	2190	25550	4.12E-05	3.53E-06	3.00E-04	1.75E+00	1.37E-01	6.18E-06	28.97%	85.63%
Barium	1.01E+02	1	14	6	1E-03	15	2190	25550	2.58E-04	2.21E-05	7.00E-02	--	3.69E-03	--	0.78%	0.00%
Beryllium	1.10E+00	1	14	6	1E-03	15	2190	25550	2.81E-06	2.41E-07	5.00E-03	4.30E+00	5.63E-04	1.04E-06	0.12%	14.37%
Cobalt	2.46E+01	1	14	6	1E-03	15	2190	25550	6.29E-05	5.39E-06	6.00E-02	--	1.05E-03	--	0.22%	0.00%
Copper	8.30E+00	1	14	6	1E-03	15	2190	25550	2.12E-05	1.82E-06	3.71E-02	--	5.72E-04	--	0.12%	0.00%
Iron	3.83E+04	1	14	6	1E-03	15	2190	25550	9.79E-02	8.39E-03	3.00E-01	--	3.26E-01	--	68.92%	0.00%
Mercury	1.50E-01	1	14	6	1E-03	15	2190	25550	3.84E-07	3.29E-08	3.00E-04	--	1.28E-03	--	0.27%	0.00%
Zinc	3.07E+02	1	14	6	1E-03	15	2190	25550	7.85E-04	6.73E-05	3.00E-01	--	2.62E-03	--	0.55%	0.00%
TOTAL													4.74E-01	7.21E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 7

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
TOTAL DISSOLVE METALS																
Aluminum	2.72E+02	2	28	30	1E−06	70	10950	25550	5.96E−07	2.55E−07	2.90E+00	--	2.06E−07	--	0.05%	0.00%
Arsenic	1.61E+01	2	28	30	1E−06	70	10950	25550	3.53E−08	1.51E−08	3.00E−04	1.75E+00	1.18E−04	2.65E−08	28.97%	85.63%
Barium	1.01E+02	2	28	30	1E−06	70	10950	25550	2.21E−07	9.49E−08	7.00E−02	--	3.16E−06	--	0.78%	0.00%
Beryllium	1.10E+00	2	28	30	1E−06	70	10950	25550	2.41E−09	1.03E−09	5.00E−03	4.30E+00	4.82E−07	4.44E−09	0.12%	14.37%
Cobalt	2.46E+01	2	28	30	1E−06	70	10950	25550	5.39E−08	2.31E−08	6.00E−02	--	8.99E−07	--	0.22%	0.00%
Copper	8.30E+00	2	28	30	1E−06	70	10950	25550	1.82E−08	7.80E−09	3.71E−02	--	4.90E−07	--	0.12%	0.00%
Iron	3.83E+04	2	28	30	1E−06	70	10950	25550	8.39E−05	3.60E−05	3.00E−01	--	2.80E−04	--	68.92%	0.00%
Mercury	1.50E−01	2	28	30	1E−06	70	10950	25550	3.29E−10	1.41E−10	3.00E−04	--	1.10E−06	--	0.27%	0.00%
Zinc	3.07E+02	2	28	30	1E−06	70	10950	25550	6.73E−07	2.88E−07	3.00E−01	--	2.24E−06	--	0.55%	0.00%
TOTAL													4.06E−04	3.09E−08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 7

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
TOTAL DISSOLVE METALS																		
Aluminum	2.72E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	5.06E-06	4.34E-07	2.90E+00	--	1.75E-06	-	0.05%	0.00%
Arsenic	1.61E+01	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	3.00E-07	2.57E-08	3.00E-04	1.75E+00	9.99E-04	4.50E-08	29.03%	85.63%
Barium	1.01E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	1.88E-06	1.61E-07	7.00E-02	--	2.69E-05	-	0.78%	0.00%
Beryllium	1.10E+00	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	2.05E-08	1.76E-09	5.00E-03	4.30E+00	4.10E-06	7.55E-09	0.12%	14.37%
Cobalt	2.46E+01	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	4.58E-07	3.93E-08	6.00E-02	--	7.63E-06	-	0.22%	0.00%
Copper	8.30E+00	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	1.55E-07	1.32E-08	3.71E-02	--	4.16E-06	-	0.12%	0.00%
Iron	3.83E+04	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	7.13E-04	6.11E-05	3.00E-01	--	2.38E-03	-	69.07%	0.00%
Mercury	1.50E-01	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	2.79E-09	2.39E-10	3.00E-04	--	9.31E-06	-	0.27%	0.00%
Zinc	3.07E+02	7280	0.0006 *	0.2	14	6	1E-06	15	2190	25550	3.43E-06	2.94E-07	3.00E-01	--	1.14E-05	-	0.33%	0.00%
TOTAL															3.44E-03	5.25E-08	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 7

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
TOTAL DISSOLVE METALS																		
Aluminum	2.72E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	6.86E-06	2.94E-06	2.90E+00	--	2.36E-06	–	0.05%	0.00%
Arsenic	1.61E+01	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	4.06E-07	1.74E-07	3.00E-04	1.75E+00	1.35E-03	3.04E-07	29.03%	85.63%
Barium	1.01E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	2.55E-06	1.09E-06	7.00E-02	--	3.64E-05	–	0.78%	0.00%
Beryllium	1.10E+00	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	2.77E-08	1.19E-08	5.00E-03	4.30E+00	5.55E-06	5.11E-08	0.12%	14.37%
Cobalt	2.46E+01	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	6.20E-07	2.66E-07	6.00E-02	--	1.03E-05	–	0.22%	0.00%
Copper	8.30E+00	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	2.09E-07	8.97E-08	3.71E-02	--	5.64E-06	–	0.12%	0.00%
Iron	3.83E+04	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	9.65E-04	4.14E-04	3.00E-01	--	3.22E-03	–	69.07%	0.00%
Mercury	1.50E-01	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	3.78E-09	1.62E-09	3.00E-04	--	1.26E-05	–	0.27%	0.00%
Zinc	3.07E+02	23000	0.0006 *	0.2	28	30	1E-06	70	10950	25550	4.64E-06	1.99E-06	3.00E-01	--	1.55E-05	–	0.33%	0.00%
TOTAL															4.66E-03	3.55E-07	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

CONSTITUENTS DETECTED IN SURFACE WATER SAMPLES
SITE 7
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)			Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Water Stds. (ug/l) [d]	Potential Concern
VOLATILES									
Acetone	3 / 6	15.0	–	31.0		370			NO
INORGANICS									
Aluminum	5 / 6	388 j	–	1690.0 j		11000			YES
Arsenic	5 / 6	2.4 b	–	10.3	0.018	0.038	50	50	YES
Barium [e]	6 / 6	17.5 b	–	36.8 b		260	2000	2000	YES
Calcium	6 / 6	22300	–	1.8E+05					NO
Cobalt [e]	4 / 6	3.4 b	–	5.6 b		220			YES
Copper [e]	4 / 6	5.3 b	–	14.1 b		140	1300	1300	YES
Iron	6 / 6	1010 j	–	6890.0 j				300	YES
Lead	3 / 6	3.2 j	–	50.0 j				15	YES *
Magnesium	6 / 6	28000	–	4.6E+05					NO
Manganese	6 / 6	83.9	–	334.0		18		50	YES
Potassium	6 / 6	8800 j	–	1.8E+05 j					NO
Sodium	6 / 6	184000	–	4.3E+06					NO
Zinc	3 / 6	30.8	–	70.5			1100	5000	YES
ANIONS									
Alkalinity	6 / 6	78500.0	–	1.3E+05					YES
Bicarbonate alkalinity	6 / 6	78500.0	–	1.3E+05					YES
Chloride	6 / 6	7.0E+05	–	2.1E+07				250000	YES
Sulfate	6 / 6	1.2E+05	–	1.4E+06				250000	YES

Notes:

a. Federal MCL concentration values represent USFederal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the January 7, 1994 RBC table.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Water Standards for public water supplies.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

e. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE WATER
SITE 7

CURRENT SCENARIO
SURFACE WATER – INGESTION
TRESPASSER CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.69E+03	2	350	6	1E−03	15	2190	25550	2.16E−01	1.85E−02	2.90E+00	--	7.45E−02	--	0.46%	0.00%
Arsenic	1.03E+01	2	350	6	1E−03	15	2190	25550	1.32E−03	1.13E−04	3.00E−04	1.75E+00	4.39E+00	1.98E−04	27.27%	100.00%
Barium	3.68E+01	2	350	6	1E−03	15	2190	25550	4.71E−03	4.03E−04	7.00E−02	--	6.72E−02	--	0.42%	0.00%
Cobalt	5.60E+00	2	350	6	1E−03	15	2190	25550	7.16E−04	6.14E−05	6.00E−02	--	1.19E−02	--	0.07%	0.00%
Copper	1.41E+01	2	350	6	1E−03	15	2190	25550	1.80E−03	1.55E−04	3.71E−02	--	4.86E−02	--	0.30%	0.00%
Iron	6.89E+03	2	350	6	1E−03	15	2190	25550	8.81E−01	7.55E−02	3.00E−01	--	2.94E+00	--	18.24%	0.00%
Manganese	3.34E+02	2	350	6	1E−03	15	2190	25550	4.27E−02	3.66E−03	5.00E−03	--	8.54E+00	--	53.05%	0.00%
Zinc	7.05E+01	2	350	6	1E−03	15	2190	25550	9.01E−03	7.73E−04	3.00E−01	--	3.00E−02	--	0.19%	0.00%
TOTAL													1.61E+01	1.98E−04	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE WATER
SITE 7

CURRENT SCENARIO
SURFACE WATER – INGESTION
TRESPASSER ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.69E+03	2	350	30	1E−06	70	10950	25550	4.63E−05	1.98E−05	2.90E+00	--	1.60E−05	--	0.46%	0.00%
Arsenic	1.03E+01	2	350	30	1E−06	70	10950	25550	2.82E−07	1.21E−07	3.00E−04	1.75E+00	9.41E−04	2.12E−07	27.27%	100.00%
Barium	3.68E+01	2	350	30	1E−06	70	10950	25550	1.01E−06	4.32E−07	7.00E−02	--	1.44E−05	--	0.42%	0.00%
Cobalt	5.60E+00	2	350	30	1E−06	70	10950	25550	1.53E−07	6.58E−08	6.00E−02	--	2.56E−06	--	0.07%	0.00%
Copper	1.41E+01	2	350	30	1E−06	70	10950	25550	3.86E−07	1.66E−07	3.71E−02	--	1.04E−05	--	0.30%	0.00%
Iron	6.89E+03	2	350	30	1E−06	70	10950	25550	1.89E−04	8.09E−05	3.00E−01	--	6.29E−04	--	18.24%	0.00%
Manganese	3.34E+02	2	350	30	1E−06	70	10950	25550	9.15E−06	3.92E−06	5.00E−03	--	1.83E−03	--	53.05%	0.00%
Zinc	7.05E+01	2	350	30	1E−06	70	10950	25550	1.93E−06	8.28E−07	3.00E−01	--	6.44E−06	--	0.19%	0.00%
TOTAL													3.45E−03	2.12E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE WATER
SITE 7

CURRENT SCENARIO
SURFACE WATER – DERMAL
TRESPASSER CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.69E+03	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	7.87E-04	6.74E-05	2.90E+00	--	2.71E-04	-	0.46%	0.00%
Arsenic	1.03E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	4.79E-06	4.11E-07	3.00E-04	1.75E+00	1.60E-02	7.19E-07	27.29%	100.00%
Barium	3.68E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.71E-05	1.47E-06	7.00E-02	--	2.45E-04	-	0.42%	0.00%
Cobalt	5.60E+00	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	2.61E-06	2.23E-07	6.00E-02	--	4.34E-05	-	0.07%	0.00%
Copper	1.41E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	6.56E-06	5.62E-07	3.71E-02	--	1.77E-04	-	0.30%	0.00%
Iron	6.89E+03	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.21E-03	2.75E-04	3.00E-01	--	1.07E-02	-	18.25%	0.00%
Manganese	3.34E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.55E-04	1.33E-05	5.00E-03	--	3.11E-02	-	53.09%	0.00%
Zinc	7.05E+01	7280	0.0006 *	2.6	350	6	1E-06	15	2190	25550	1.97E-05	1.69E-06	3.00E-01	--	6.56E-05	-	0.11%	0.00%
TOTAL															5.86E-02	7.19E-07	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE WATER
SITE 7

CURRENT SCENARIO
SURFACE WATER – DERMAL
TRESPASSER ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.69E+03	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	5.32E-04	2.28E-04	2.90E+00	--	1.84E-04	–	0.46%	0.00%
Arsenic	1.03E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	3.25E-06	1.39E-06	3.00E-04	1.75E+00	1.08E-02	2.43E-06	27.29%	100.00%
Barium	3.68E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	1.16E-05	4.97E-06	7.00E-02	--	1.66E-04	–	0.42%	0.00%
Cobalt	5.60E+00	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	1.76E-06	7.56E-07	6.00E-02	--	2.94E-05	–	0.07%	0.00%
Copper	1.41E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	4.44E-06	1.90E-06	3.71E-02	--	1.20E-04	–	0.30%	0.00%
Iron	6.89E+03	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.17E-03	9.30E-04	3.00E-01	--	7.24E-03	–	18.25%	0.00%
Manganese	3.34E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	1.05E-04	4.51E-05	5.00E-03	--	2.10E-02	–	53.09%	0.00%
Zinc	7.05E+01	23000	0.0006 *	2.6	350	30	1E-06	70	10950	25550	1.33E-05	5.71E-06	3.00E-01	--	4.44E-05	–	0.11%	0.00%
TOTAL															3.96E-02	2.43E-06	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE WATER
SITE 7

FUTURE SCENARIO
SURFACE WATER -- INGESTION
RESIDENT CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.69E+03	2	350	6	1E-03	15	2190	25550	2.16E-01	1.85E-02	2.90E+00	--	7.45E-02	--	0.46%	0.00%
Arsenic	1.03E+01	2	350	6	1E-03	15	2190	25550	1.32E-03	1.13E-04	3.00E-04	1.75E+00	4.39E+00	1.98E-04	27.27%	100.00%
Barium	3.68E+01	2	350	6	1E-03	15	2190	25550	4.71E-03	4.03E-04	7.00E-02	--	6.72E-02	--	0.42%	0.00%
Cobalt	5.60E+00	2	350	6	1E-03	15	2190	25550	7.16E-04	6.14E-05	6.00E-02	--	1.19E-02	--	0.07%	0.00%
Copper	1.41E+01	2	350	6	1E-03	15	2190	25550	1.80E-03	1.55E-04	3.71E-02	--	4.86E-02	--	0.30%	0.00%
Iron	6.89E+03	2	350	6	1E-03	15	2190	25550	8.81E-01	7.55E-02	3.00E-01	--	2.94E+00	--	18.24%	0.00%
Manganese	3.34E+02	2	350	6	1E-03	15	2190	25550	4.27E-02	3.66E-03	5.00E-03	--	8.54E+00	--	53.05%	0.00%
Zinc	7.05E+01	2	350	6	1E-03	15	2190	25550	9.01E-03	7.73E-04	3.00E-01	--	3.00E-02	--	0.19%	0.00%
TOTAL													1.61E+01	1.98E-04	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE WATER
SITE 7

FUTURE SCENARIO
SURFACE WATER – INGESTION
RESIDENT ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.69E+03	2	350	30	1E−06	70	10950	25550	4.63E−05	1.98E−05	2.90E+00	--	1.60E−05	--	0.46%	0.00%
Arsenic	1.03E+01	2	350	30	1E−06	70	10950	25550	2.82E−07	1.21E−07	3.00E−04	1.75E+00	9.41E−04	2.12E−07	27.27%	100.00%
Barium	3.68E+01	2	350	30	1E−06	70	10950	25550	1.01E−06	4.32E−07	7.00E−02	--	1.44E−05	--	0.42%	0.00%
Cobalt	5.60E+00	2	350	30	1E−06	70	10950	25550	1.53E−07	6.58E−08	6.00E−02	--	2.56E−06	--	0.07%	0.00%
Copper	1.41E+01	2	350	30	1E−06	70	10950	25550	3.86E−07	1.66E−07	3.71E−02	--	1.04E−05	--	0.30%	0.00%
Iron	6.89E+03	2	350	30	1E−06	70	10950	25550	1.89E−04	8.09E−05	3.00E−01	--	6.29E−04	--	18.24%	0.00%
Manganese	3.34E+02	2	350	30	1E−06	70	10950	25550	9.15E−06	3.92E−06	5.00E−03	--	1.83E−03	--	53.05%	0.00%
Zinc	7.05E+01	2	350	30	1E−06	70	10950	25550	1.93E−06	8.28E−07	3.00E−01	--	6.44E−06	--	0.19%	0.00%
TOTAL													3.45E−03	2.12E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE WATER
SITE 7

FUTURE SCENARIO
SURFACE WATER – DERMAL
RESIDENT CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.69E+03	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	7.87E-04	6.74E-05	2.90E+00	--	2.71E-04	-	0.46%	0.00%
Arsenic	1.03E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	4.79E-06	4.11E-07	3.00E-04	1.75E+00	1.60E-02	7.19E-07	27.29%	100.00%
Barium	3.68E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.71E-05	1.47E-06	7.00E-02	--	2.45E-04	-	0.42%	0.00%
Cobalt	5.60E+00	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	2.61E-06	2.23E-07	6.00E-02	--	4.34E-05	-	0.07%	0.00%
Copper	1.41E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	6.56E-06	5.62E-07	3.71E-02	--	1.77E-04	-	0.30%	0.00%
Iron	6.89E+03	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.21E-03	2.75E-04	3.00E-01	--	1.07E-02	-	18.25%	0.00%
Manganese	3.34E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.55E-04	1.33E-05	5.00E-03	--	3.11E-02	-	53.09%	0.00%
Zinc	7.05E+01	7280	0.0006 *	2.6	350	6	1E-06	15	2190	25550	1.97E-05	1.69E-06	3.00E-01	--	6.56E-05	-	0.11%	0.00%
TOTAL															5.86E-02	7.19E-07	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE WATER
SITE 7

FUTURE SCENARIO
SURFACE WATER – DERMAL
RESIDENT ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	1.69E+03	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	5.32E-04	2.28E-04	2.90E+00	--	1.84E-04	-	0.46%	0.00%
Arsenic	1.03E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	3.25E-06	1.39E-06	3.00E-04	1.75E+00	1.08E-02	2.43E-06	27.29%	100.00%
Barium	3.68E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	1.16E-05	4.97E-06	7.00E-02	--	1.66E-04	-	0.42%	0.00%
Cobalt	5.60E+00	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	1.76E-06	7.56E-07	6.00E-02	--	2.94E-05	-	0.07%	0.00%
Copper	1.41E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	4.44E-06	1.90E-06	3.71E-02	--	1.20E-04	-	0.30%	0.00%
Iron	6.89E+03	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.17E-03	9.30E-04	3.00E-01	--	7.24E-03	-	18.25%	0.00%
Manganese	3.34E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	1.05E-04	4.51E-05	5.00E-03	--	2.10E-02	-	53.09%	0.00%
Zinc	7.05E+01	23000	0.0006 *	2.6	350	30	1E-06	70	10950	25550	1.33E-05	5.71E-06	3.00E-01	--	4.44E-05	-	0.11%	0.00%
TOTAL															3.96E-02	2.43E-06	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

CONSTITUENTS DETECTED IN SEDIMENT SAMPLES
SITE 7
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (mg/kg)			Residential Soil Conc. (mg/kg) [a]	Potential Concern
VOLATILES						
Methylene chloride	1 / 6		7E–03 j		8.50E+01	NO
Acetone	1 / 6		4E–01 j		7.80E+02	NO
Carbon disulfide	1 / 6		4E–03 j		7.80E+02	NO
2–Butanone	3 / 6	0.012 j	–	7E–02		NO
Toluene	2 / 6	0.001 j	–	5E–03 j	1.60E+03	NO
INORGANICS						
Aluminum	6 / 6	221	–	6520.0	2.30E+04	YES
Arsenic	6 / 6	1.2 b	–	8.6	3.70E–01	YES
Barium [b]	6 / 6	1.6 b	–	23.8 b	5.50E+02	YES
Beryllium [b]	2 / 6	0.28 b	–	0.4 b	1.50E–01	YES
Cadmium	3 / 6	2.3	–	3.1	3.90E+01	YES
Calcium	5 / 6	214	–	1500.0		NO
Chromium	6 / 6	1.5 j	–	10.1 j	3.90E+01	YES
Cobalt	4 / 6	0.94 j	–	3.4 j	4.70E+02	YES
Copper	6 / 6	0.89	–	42.9	2.90E+02	YES
Iron	6 / 6	1060	–	1.4E+04		YES
Lead	6 / 6	1.7 j	–	31.1		YES*
Magnesium	6 / 6	78.7	–	2680.0		NO
Manganese	6 / 6	2.7 b	–	67.2	3.90E+01	YES
Nickel [b]	5 / 6	3.3 b	–	7.6 b	1.60E+02	YES
Potassium	6 / 6	45.3	–	1350.0		YES
Silver	1 / 6		0.8 j		3.90E+01	NO
Sodium	6 / 6	299	–	5160.0		YES
Vanadium	5 / 6	5.4 b	–	23.2	5.50E+01	YES
Zinc	5 / 6	29.5	–	213.0	2.30E+03	YES
ANIONS						
Alkalinity	2 / 6	0.10	–	6.3E–01		YES
Bicarbonate alkalinity	2 / 6	0.10	–	6.3E–01		YES
Chloride	6 / 6	0.55	–	7.5E+00		YES
Sulfate	5 / 6	0.14	–	1.2E+00		YES

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum where it is obtained from the January 11, 1994 RBC Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

b. Constituent concentration is five times greater than the maximum detected in blank (b).

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SEDIMENT
SITE 7

CURRENT SCENARIO
SEDIMENT – INGESTION
TRESPASSER CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	6.52E+03	100	1	14	6	1E−06	15	2190	25550	1.67E−03	1.43E−04	2.90E+00	--	5.75E−04	--	2.14%	0.00%
Arsenic	8.60E+00	100	1	14	6	1E−06	15	2190	25550	2.20E−06	1.88E−07	3.00E−04	1.75E+00	7.33E−03	3.30E−07	27.23%	89.74%
Barium	2.38E+01	100	1	14	6	1E−06	15	2190	25550	6.09E−06	5.22E−07	7.00E−02	--	8.69E−05	--	0.32%	0.00%
Beryllium	4.00E−01	100	1	14	6	1E−06	15	2190	25550	1.02E−07	8.77E−09	5.00E−03	4.30E+00	2.05E−05	3.77E−08	0.08%	10.26%
Cadmium	3.10E+00	100	1	14	6	1E−06	15	2190	25550	7.93E−07	6.79E−08	5.00E−04	--	1.59E−03	--	5.89%	0.00%
Chromium	1.01E+01	100	1	14	6	1E−06	15	2190	25550	2.58E−06	2.21E−07	5.00E−03	--	5.17E−04	--	1.92%	0.00%
Cobalt	3.40E+00	100	1	14	6	1E−06	15	2190	25550	8.69E−07	7.45E−08	6.00E−02	--	1.45E−05	--	0.05%	0.00%
Copper	4.29E+01	100	1	14	6	1E−06	15	2190	25550	1.10E−05	9.40E−07	3.71E−02	--	2.96E−04	--	1.10%	0.00%
Iron	1.40E+04	100	1	14	6	1E−06	15	2190	25550	3.58E−03	3.07E−04	3.00E−01	--	1.19E−02	--	44.33%	0.00%
Manganese	6.72E+01	100	1	14	6	1E−06	15	2190	25550	1.72E−05	1.47E−06	5.00E−03	--	3.44E−03	--	12.77%	0.00%
Nickel	7.60E+00	100	1	14	6	1E−06	15	2190	25550	1.94E−06	1.67E−07	2.00E−02	--	9.72E−05	--	0.36%	0.00%
Vanadium	2.32E+01	100	1	14	6	1E−06	15	2190	25550	5.93E−06	5.08E−07	7.00E−03	--	8.47E−04	--	3.15%	0.00%
Zinc	2.13E+02	100	1	14	6	1E−06	15	2190	25550	5.45E−05	4.67E−06	3.00E−01	--	1.82E−04	--	0.67%	0.00%
TOTAL														2.69E−02	3.68E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SEDIMENT
SITE 7

CURRENT SCENARIO
SEDIMENT – INGESTION
TRESPASSER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	6.52E+03	50	1	28	30	1E−06	70	10950	25550	3.57E−04	1.53E−04	2.90E+00	--	1.23E−04	--	2.14%	0.00%
Arsenic	8.60E+00	50	1	28	30	1E−06	70	10950	25550	4.71E−07	2.02E−07	3.00E−04	1.75E+00	1.57E−03	3.53E−07	27.23%	89.74%
Barium	2.38E+01	50	1	28	30	1E−06	70	10950	25550	1.30E−06	5.59E−07	7.00E−02	--	1.86E−05	--	0.32%	0.00%
Beryllium	4.00E−01	50	1	28	30	1E−06	70	10950	25550	2.19E−08	9.39E−09	5.00E−03	4.30E+00	4.38E−06	4.04E−08	0.08%	10.26%
Cadmium	3.10E+00	50	1	28	30	1E−06	70	10950	25550	1.70E−07	7.28E−08	5.00E−04	--	3.40E−04	--	5.89%	0.00%
Chromium	1.01E+01	50	1	28	30	1E−06	70	10950	25550	5.53E−07	2.37E−07	5.00E−03	--	1.11E−04	--	1.92%	0.00%
Cobalt	3.40E+00	50	1	28	30	1E−06	70	10950	25550	1.86E−07	7.98E−08	6.00E−02	--	3.11E−06	--	0.05%	0.00%
Copper	4.29E+01	50	1	28	30	1E−06	70	10950	25550	2.35E−06	1.01E−06	3.71E−02	--	6.34E−05	--	1.10%	0.00%
Iron	1.40E+04	50	1	28	30	1E−06	70	10950	25550	7.67E−04	3.29E−04	3.00E−01	--	2.56E−03	--	44.33%	0.00%
Manganese	6.72E+01	50	1	28	30	1E−06	70	10950	25550	3.68E−06	1.58E−06	5.00E−03	--	7.36E−04	--	12.77%	0.00%
Nickel	7.60E+00	50	1	28	30	1E−06	70	10950	25550	4.16E−07	1.78E−07	2.00E−02	--	2.08E−05	--	0.36%	0.00%
Vanadium	2.32E+01	50	1	28	30	1E−06	70	10950	25550	1.27E−06	5.45E−07	7.00E−03	--	1.82E−04	--	3.15%	0.00%
Zinc	2.13E+02	50	1	28	30	1E−06	70	10950	25550	1.17E−05	5.00E−06	3.00E−01	--	3.89E−05	--	0.67%	0.00%
TOTAL														5.77E−03	3.94E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SEDIMENT
SITE 7

CURRENT SCENARIO
SEDIMENT – DERMAL
TRESPASSER CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	6.52E+03	1820	1	0.001	14	6	1E-06	15	2190	25550	3.03E-05	2.60E-06	2.90E+00	--	1.05E-05	–	2.14%	0.00%
Arsenic	8.60E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	4.00E-08	3.43E-09	3.00E-04	1.75E+00	1.33E-04	6.00E-09	27.23%	89.74%
Barium	2.38E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.11E-07	9.49E-09	7.00E-02	--	1.58E-06	–	0.32%	0.00%
Beryllium	4.00E-01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.86E-09	1.60E-10	5.00E-03	4.30E+00	3.72E-07	6.86E-10	0.08%	10.26%
Cadmium	3.10E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.44E-08	1.24E-09	5.00E-04	--	2.89E-05	–	5.89%	0.00%
Chromium	1.01E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	4.70E-08	4.03E-09	5.00E-03	--	9.40E-06	–	1.92%	0.00%
Cobalt	3.40E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.58E-08	1.36E-09	6.00E-02	--	2.64E-07	–	0.05%	0.00%
Copper	4.29E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	2.00E-07	1.71E-08	3.71E-02	--	5.38E-06	–	1.10%	0.00%
Iron	1.40E+04	1820	1	0.001	14	6	1E-06	15	2190	25550	6.52E-05	5.58E-06	3.00E-01	--	2.17E-04	–	44.33%	0.00%
Manganese	6.72E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	3.13E-07	2.68E-08	5.00E-03	--	6.25E-05	–	12.77%	0.00%
Nickel	7.60E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	3.54E-08	3.03E-09	2.00E-02	--	1.77E-06	–	0.36%	0.00%
Vanadium	2.32E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.08E-07	9.25E-09	7.00E-03	--	1.54E-05	–	3.15%	0.00%
Zinc	2.13E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	9.91E-07	8.50E-08	3.00E-01	--	3.30E-06	–	0.67%	0.00%
TOTAL															4.90E-04	6.69E-09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SEDIMENT
SITE 7

CURRENT SCENARIO
SEDIMENT – DERMAL
TRESPASSER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	6.52E+03	5800	1	0.001	28	30	1E-06	70	10950	25550	4.14E-05	1.78E-05	2.90E+00	--	1.43E-05	--	2.14%	0.00%
Arsenic	8.60E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	5.47E-08	2.34E-08	3.00E-04	1.75E+00	1.82E-04	4.10E-08	27.23%	89.74%
Barium	2.38E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.51E-07	6.48E-08	7.00E-02	--	2.16E-06	--	0.32%	0.00%
Beryllium	4.00E-01	5800	1	0.001	28	30	1E-06	70	10950	25550	2.54E-09	1.09E-09	5.00E-03	4.30E+00	5.08E-07	4.69E-09	0.08%	10.26%
Cadmium	3.10E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	1.97E-08	8.44E-09	5.00E-04	--	3.94E-05	--	5.89%	0.00%
Chromium	1.01E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	6.42E-08	2.75E-08	5.00E-03	--	1.28E-05	--	1.92%	0.00%
Cobalt	3.40E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	2.16E-08	9.26E-09	6.00E-02	--	3.60E-07	--	0.05%	0.00%
Copper	4.29E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	2.73E-07	1.17E-07	3.71E-02	--	7.35E-06	--	1.10%	0.00%
Iron	1.40E+04	5800	1	0.001	28	30	1E-06	70	10950	25550	8.90E-05	3.81E-05	3.00E-01	--	2.97E-04	--	44.33%	0.00%
Manganese	6.72E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	4.27E-07	1.83E-07	5.00E-03	--	8.54E-05	--	12.77%	0.00%
Nickel	7.60E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	4.83E-08	2.07E-08	2.00E-02	--	2.42E-06	--	0.36%	0.00%
Vanadium	2.32E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.47E-07	6.32E-08	7.00E-03	--	2.11E-05	--	3.15%	0.00%
Zinc	2.13E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	1.35E-06	5.80E-07	3.00E-01	--	4.51E-06	--	0.67%	0.00%
TOTAL															6.69E-04	4.57E-08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SEDIMENT
SITE 7

FUTURE SCENARIO
SEDIMENT – INGESTION
RESIDENT CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	6.52E+03	100	1	14	6	1E-06	15	2190	25550	1.67E-03	1.43E-04	2.90E+00	--	5.75E-04	--	2.14%	0.00%
Arsenic	8.60E+00	100	1	14	6	1E-06	15	2190	25550	2.20E-06	1.88E-07	3.00E-04	1.75E+00	7.33E-03	3.30E-07	27.23%	89.74%
Barium	2.38E+01	100	1	14	6	1E-06	15	2190	25550	6.09E-06	5.22E-07	7.00E-02	--	8.69E-05	--	0.32%	0.00%
Beryllium	4.00E-01	100	1	14	6	1E-06	15	2190	25550	1.02E-07	8.77E-09	5.00E-03	4.30E+00	2.05E-05	3.77E-08	0.08%	10.26%
Cadmium	3.10E+00	100	1	14	6	1E-06	15	2190	25550	7.93E-07	6.79E-08	5.00E-04	--	1.59E-03	--	5.89%	0.00%
Chromium	1.01E+01	100	1	14	6	1E-06	15	2190	25550	2.58E-06	2.21E-07	5.00E-03	--	5.17E-04	--	1.92%	0.00%
Cobalt	3.40E+00	100	1	14	6	1E-06	15	2190	25550	8.69E-07	7.45E-08	6.00E-02	--	1.45E-05	--	0.05%	0.00%
Copper	4.29E+01	100	1	14	6	1E-06	15	2190	25550	1.10E-05	9.40E-07	3.71E-02	--	2.96E-04	--	1.10%	0.00%
Iron	1.40E+04	100	1	14	6	1E-06	15	2190	25550	3.58E-03	3.07E-04	3.00E-01	--	1.19E-02	--	44.33%	0.00%
Manganese	6.72E+01	100	1	14	6	1E-06	15	2190	25550	1.72E-05	1.47E-06	5.00E-03	--	3.44E-03	--	12.77%	0.00%
Nickel	7.60E+00	100	1	14	6	1E-06	15	2190	25550	1.94E-06	1.67E-07	2.00E-02	--	9.72E-05	--	0.36%	0.00%
Vanadium	2.32E+01	100	1	14	6	1E-06	15	2190	25550	5.93E-06	5.08E-07	7.00E-03	--	8.47E-04	--	3.15%	0.00%
Zinc	2.13E+02	100	1	14	6	1E-06	15	2190	25550	5.45E-05	4.67E-06	3.00E-01	--	1.82E-04	--	0.67%	0.00%
TOTAL														2.69E-02	3.68E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SEDIMENT
SITE 7

FUTURE SCENARIO
SEDIMENT – INGESTION
RESIDENT ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	6.52E+03	50	1	28	30	1E−06	70	10950	25550	3.57E−04	1.53E−04	2.90E+00	--	1.23E−04	--	2.14%	0.00%
Arsenic	8.60E+00	50	1	28	30	1E−06	70	10950	25550	4.71E−07	2.02E−07	3.00E−04	1.75E+00	1.57E−03	3.53E−07	27.23%	89.74%
Barium	2.38E+01	50	1	28	30	1E−06	70	10950	25550	1.30E−06	5.59E−07	7.00E−02	--	1.86E−05	--	0.32%	0.00%
Beryllium	4.00E−01	50	1	28	30	1E−06	70	10950	25550	2.19E−08	9.39E−09	5.00E−03	4.30E+00	4.38E−06	4.04E−08	0.08%	10.26%
Cadmium	3.10E+00	50	1	28	30	1E−06	70	10950	25550	1.70E−07	7.28E−08	5.00E−04	--	3.40E−04	--	5.89%	0.00%
Chromium	1.01E+01	50	1	28	30	1E−06	70	10950	25550	5.53E−07	2.37E−07	5.00E−03	--	1.11E−04	--	1.92%	0.00%
Cobalt	3.40E+00	50	1	28	30	1E−06	70	10950	25550	1.86E−07	7.98E−08	6.00E−02	--	3.11E−06	--	0.05%	0.00%
Copper	4.29E+01	50	1	28	30	1E−06	70	10950	25550	2.35E−06	1.01E−06	3.71E−02	--	6.34E−05	--	1.10%	0.00%
Iron	1.40E+04	50	1	28	30	1E−06	70	10950	25550	7.67E−04	3.29E−04	3.00E−01	--	2.56E−03	--	44.33%	0.00%
Manganese	6.72E+01	50	1	28	30	1E−06	70	10950	25550	3.68E−06	1.58E−06	5.00E−03	--	7.36E−04	--	12.77%	0.00%
Nickel	7.60E+00	50	1	28	30	1E−06	70	10950	25550	4.16E−07	1.78E−07	2.00E−02	--	2.08E−05	--	0.36%	0.00%
Vanadium	2.32E+01	50	1	28	30	1E−06	70	10950	25550	1.27E−06	5.45E−07	7.00E−03	--	1.82E−04	--	3.15%	0.00%
Zinc	2.13E+02	50	1	28	30	1E−06	70	10950	25550	1.17E−05	5.00E−06	3.00E−01	--	3.89E−05	--	0.67%	0.00%
TOTAL														5.77E−03	3.94E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SEDIMENT
SITE 7

FUTURE SCENARIO
SEDIMENT – DERMAL
RESIDENT CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	6.52E+03	1820	1	0.001	14	6	1E-06	15	2190	25550	3.03E-05	2.60E-06	2.90E+00	--	1.05E-05	--	2.14%	0.00%
Arsenic	8.60E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	4.00E-08	3.43E-09	3.00E-04	1.75E+00	1.33E-04	6.00E-09	27.23%	89.74%
Barium	2.38E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.11E-07	9.49E-09	7.00E-02	--	1.58E-06	--	0.32%	0.00%
Beryllium	4.00E-01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.86E-09	1.60E-10	5.00E-03	4.30E+00	3.72E-07	6.86E-10	0.08%	10.26%
Cadmium	3.10E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.44E-08	1.24E-09	5.00E-04	--	2.89E-05	--	5.89%	0.00%
Chromium	1.01E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	4.70E-08	4.03E-09	5.00E-03	--	9.40E-06	--	1.92%	0.00%
Cobalt	3.40E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.58E-08	1.36E-09	6.00E-02	--	2.64E-07	--	0.05%	0.00%
Copper	4.29E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	2.00E-07	1.71E-08	3.71E-02	--	5.38E-06	--	1.10%	0.00%
Iron	1.40E+04	1820	1	0.001	14	6	1E-06	15	2190	25550	6.52E-05	5.58E-06	3.00E-01	--	2.17E-04	--	44.33%	0.00%
Manganese	6.72E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	3.13E-07	2.68E-08	5.00E-03	--	6.25E-05	--	12.77%	0.00%
Nickel	7.60E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	3.54E-08	3.03E-09	2.00E-02	--	1.77E-06	--	0.36%	0.00%
Vanadium	2.32E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.08E-07	9.25E-09	7.00E-03	--	1.54E-05	--	3.15%	0.00%
Zinc	2.13E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	9.91E-07	8.50E-08	3.00E-01	--	3.30E-06	--	0.67%	0.00%
TOTAL															4.90E-04	6.69E-09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SEDIMENT
SITE 7

FUTURE SCENARIO
SEDIMENT – DERMAL
RESIDENT ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aluminum	6.52E+03	5800	1	0.001	28	30	1E-06	70	10950	25550	4.14E-05	1.78E-05	2.90E+00	--	1.43E-05	–	2.14%	0.00%
Arsenic	8.60E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	5.47E-08	2.34E-08	3.00E-04	1.75E+00	1.82E-04	4.10E-08	27.23%	89.74%
Barium	2.38E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.51E-07	6.48E-08	7.00E-02	--	2.16E-06	–	0.32%	0.00%
Beryllium	4.00E-01	5800	1	0.001	28	30	1E-06	70	10950	25550	2.54E-09	1.09E-09	5.00E-03	4.30E+00	5.08E-07	4.69E-09	0.08%	10.26%
Cadmium	3.10E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	1.97E-08	8.44E-09	5.00E-04	--	3.94E-05	–	5.89%	0.00%
Chromium	1.01E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	6.42E-08	2.75E-08	5.00E-03	--	1.28E-05	–	1.92%	0.00%
Cobalt	3.40E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	2.16E-08	9.26E-09	6.00E-02	--	3.60E-07	–	0.05%	0.00%
Copper	4.29E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	2.73E-07	1.17E-07	3.71E-02	--	7.35E-06	–	1.10%	0.00%
Iron	1.40E+04	5800	1	0.001	28	30	1E-06	70	10950	25550	8.90E-05	3.81E-05	3.00E-01	--	2.97E-04	–	44.33%	0.00%
Manganese	6.72E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	4.27E-07	1.83E-07	5.00E-03	--	8.54E-05	–	12.77%	0.00%
Nickel	7.60E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	4.83E-08	2.07E-08	2.00E-02	--	2.42E-06	–	0.36%	0.00%
Vanadium	2.32E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.47E-07	6.32E-08	7.00E-03	--	2.11E-05	–	3.15%	0.00%
Zinc	2.13E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	1.35E-06	5.80E-07	3.00E-01	--	4.51E-06	–	0.67%	0.00%
TOTAL															6.69E-04	4.57E-08	100.00%	100.00%

CONSTITUENTS DETECTED IN SURFACE WATER SAMPLES
SITE 7
AVAILABLE FOR FISH CONSUMPTION
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)	Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Water Stds. (ug/l) [d]	Potential Concern
VOLATILES							
Acetone	3 / 6	15.0 – 31.0		370			NO
INORGANICS							
Aluminum	5 / 6	388 j – 1690.0 j		11000			YES
Arsenic	5 / 6	2.4 b – 10.3	0.018	0.038	50	50	YES
Barium [e]	6 / 6	17.5 b – 36.8 b		260	2000	2000	YES
Calcium	6 / 6	22300 – 1.8E+05					NO
Cobalt [e]	4 / 6	3.4 b – 5.6 b		220			YES
Copper [e]	4 / 6	5.3 b – 14.1 b		140	1300	1300	YES
Iron	6 / 6	1010 j – 6890.0 j				300	YES
Lead	3 / 6	3.2 j – 50.0 j				15	YES *
Magnesium	6 / 6	28000 – 4.6E+05					NO
Manganese	6 / 6	83.9 – 334.0		18		50	YES
Potassium	6 / 6	8800 j – 1.8E+05 j					NO
Sodium	6 / 6	184000 – 4.3E+06					NO
Zinc	3 / 6	30.8 – 70.5			1100	5000	YES
ANIONS							
Alkalinity	6 / 6	78500.0 – 1.3E+05					YES
Bicarbonate alkalinity	6 / 6	78500.0 – 1.3E+05					YES
Chloride	6 / 6	7.0E+05 – 2.1E+07				250000	YES
Sulfate	6 / 6	1.2E+05 – 1.4E+06				250000	YES

Notes:

a. Federal MCL concentration values represent USFederal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk-Based Concentration Table except for aluminum which is obtained from the January 7, 1994 RBC table.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Water Standards for public water supplies.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

e. Constituent concentration is five times greater than the maximum detected in blank (b).

CONSTITUENTS CONCENTRATION IN FISH
SITE 7
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Maximum Detected Concentrations (ug/l)	Maximum Detected Concentrations (mg/l)	Bioconcentration Factor* (l/kg)	Fish Concentration (mg/kg)	Fish Criteria (mg/kg) **	Poter Conc
INORGANICS						
Aluminum	1690 j	1.69E+00 j	--	--	--	YES *'
Arsenic	10.3	1.03E-02	44	4.53E-01	1.80E-03	YES
Barium	36.8 b	3.68E-02 b	--	--	9.50E+00	YES *'
Cobalt	5.6 b	5.60E-03 b	--	--	8.10E+00	YES *'
Copper	14.1 b	1.41E-02 b	200	2.82E+00 b	5.00E+00	NO
Iron	6890 j	6.89E+00 j	--	--	--	YES *'
Lead	50.0 j	5.00E-02 j	49	2.45E+00 j	--	YES *'
Manganese	334.0	3.34E-01	--	--	6.80E-01	YES *'
Zinc	70.5	7.05E-02	47	3.31E+00	4.10E+01	NO

* Source: USEPA Superfund Public Health Evaluation Manual, EPA/540/1-86/060, October 1986
** Fish Concentration values obtained from July 11, 1994 USEPA Region III Risk-Based Concentration Table.
*** Not evaluated due to unavailable bioconcentration factor for fish.
**** Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF FISH
SITE 7

CURRENT SCENARIO
FISH – INGESTION
TRESPASSER CHILD

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.53E−01	6.5	1	350	6	1E−03	15	2190	25550	1.88E−04	1.61E−05	3.00E−04	1.75E+00	6.27E−01	2.82E−05	100.00%	100.00%
TOTAL														6.27E−01	2.82E−05	100.00%	100.00%

CURRENT SCENARIO
FISH – INGESTION
TRESPASSER ADULT

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.53E−01	6.5	1	350	30	1E−03	70	10950	25550	4.03E−05	1.73E−05	3.00E−04	1.75E+00	1.34E−01	3.03E−05	100.00%	100.00%
TOTAL														1.34E−01	3.03E−05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF FISH
SITE 7

CURRENT SCENARIO
FISH – INGESTION
RECREATIONAL CHILD

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.53E−01	6.5	1	14	9	1E−03	36	2190	25550	4.71E−06	4.03E−07	3.00E−04	1.75E+00	1.57E−02	7.06E−07	100.00%	100.00%
TOTAL														1.57E−02	7.06E−07	100.00%	100.00%

CURRENT SCENARIO
FISH – INGESTION
RECREATIONAL ADULT

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.53E−01	6.5	1	28	30	1E−03	70	10950	25550	3.23E−06	1.38E−06	3.00E−04	1.75E+00	1.08E−02	2.42E−06	100.00%	100.00%
TOTAL														1.08E−02	2.42E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF FISH
SITE 7

FUTURE SCENARIO
FISH – INGESTION
RESIDENT CHILD

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.53E−01	6.5	1	350	6	1E−03	15	2190	25550	1.88E−04	1.61E−05	3.00E−04	1.75E+00	6.27E−01	2.82E−05	100.00%	100.00%
TOTAL														6.27E−01	2.82E−05	100.00%	100.00%

FUTURE SCENARIO
FISH – INGESTION
RESIDENT ADULT

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.53E−01	6.5	1	350	30	1E−03	70	10950	25550	4.03E−05	1.73E−05	3.00E−04	1.75E+00	1.34E−01	3.03E−05	100.00%	100.00%
TOTAL														1.34E−01	3.03E−05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF FISH
SITE 7

FUTURE SCENARIO
FISH – INGESTION
RECREATIONAL CHILD

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.53E−01	6.5	1	14	9	1E−03	36	2190	25550	4.71E−06	4.03E−07	3.00E−04	1.75E+00	1.57E−02	7.06E−07	100.00%	100.00%
TOTAL														1.57E−02	7.06E−07	100.00%	100.00%

FUTURE SCENARIO
FISH – INGESTION
RECREATIONAL ADULT

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.53E−01	6.5	1	28	30	1E−03	70	10950	25550	3.23E−06	1.38E−06	3.00E−04	1.75E+00	1.08E−02	2.42E−06	100.00%	100.00%
TOTAL														1.08E−02	2.42E−06	100.00%	100.00%

IEUBK MODEL OPTIONS
SITE - 7

Parameter	Default Option	User Defined Option
Air		
Outdoor air lead concentration ($\mu g/m^3$)	0.10	0.00
Ratio of indoor to outdoor air lead concentration (%)	30	00
Time outdoors (hours/day)		
Age =		
0-1 year (0-11 mo)	1	1
1-2 years (12-23 mo)	2	2
2-3 years (24-35 mo)	3	3
3-7 years (36-83 mo)	4	4
Ventilation rate (m^2/day)		
Age =		
0-1 year (0-11 mo)	2	2
1-2 years (12-23 mo)	3	3
2-3 years (24-35 mo)	5	5
3-4 years (36-47 mo)	5	5
4-5 years (48-59 mo)	5	5
5-6 years (60-71 mo)	7	7
6-7 years (72-84 mo)	7	7
Lung absorption (%)	32	00
Dietary lead intake ($\mu g/m^3$)		
Age =		
0-1 year (0-11 mo)	5.53	0.00
1-2 years (12-23 mo)	5.78	0.00
2-3 years (24-35 mo)	6.49	0.00
3-4 years (36-47 mo)	6.24	0.00
4-5 years (48-59 mo)	6.01	0.00
5-6 years (60-71 mo)	6.34	0.00
6-7 years (72-84 mo)	7.00	0.00
Alternate Diet Sources		
Concentration (μg Pb/g)		
home-grown fruits	0	0.000
home-grown vegetables	0	0.000
fish from fishing	0	0.950
game from hunting	0	0.000
Percent of food class (%)		
home-grown fruits	0	0
home-grown vegetables	0	0
fish from fishing	0	100
game from hunting	0	0

IEUBK MODEL OPTIONS

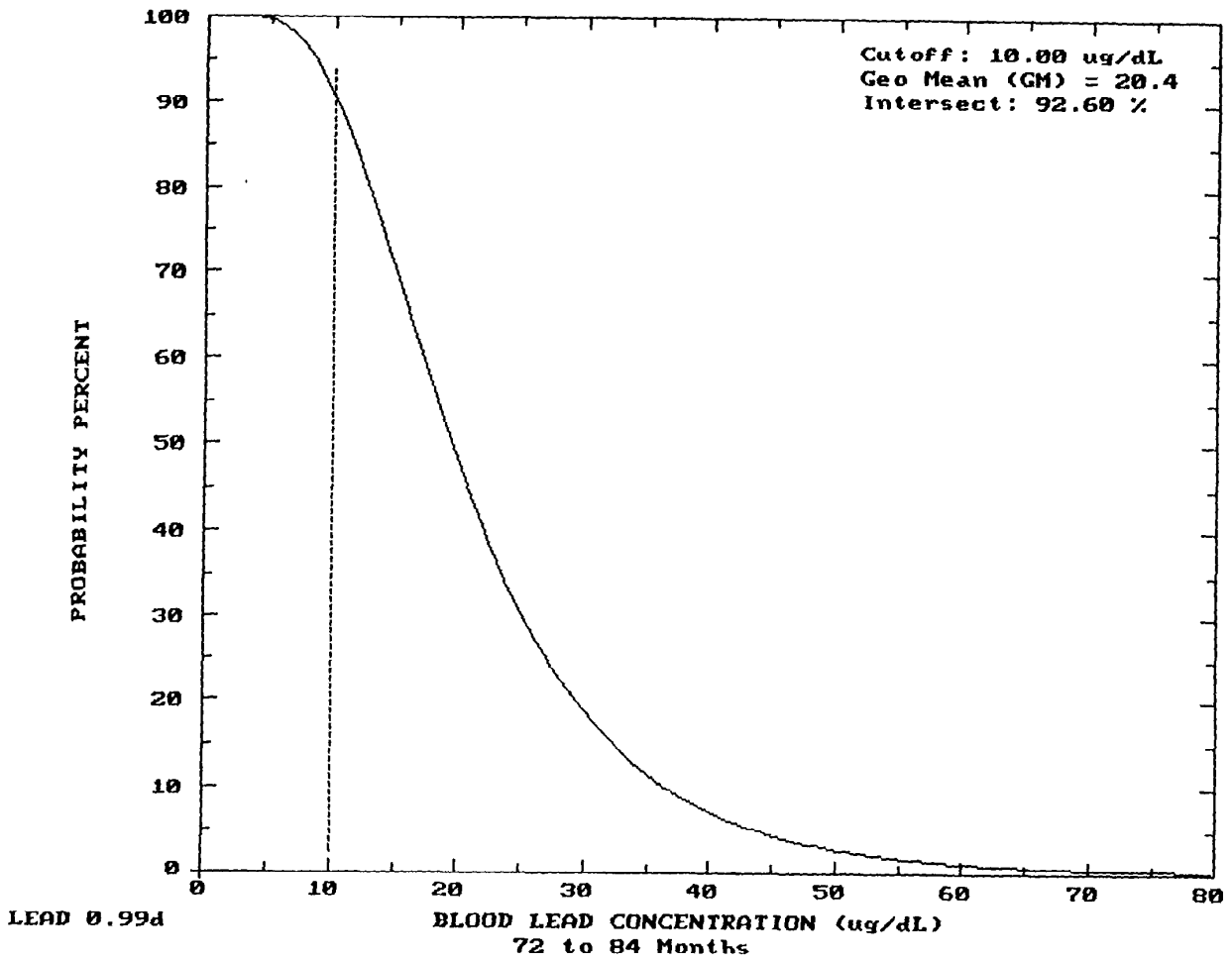
SITE - 7 (Continued)

Parameter	Default Option	User Defined Option
Drinking Water		
Lead concentration in drinking water (μg/L)	4	45.50
Ingestion rate (liters/day)		
Age =		
0-1 year (0-11 mo)	0.20	2
1-2 years (12-23 mo)	0.50	2
2-3 years (24-35 mo)	0.52	2
3-4 years (36-47 mo)	0.53	2
4-5 years (48-59 mo)	0.55	2
5-6 years (60-71 mo)	0.58	2
6-7 years (72-84 mo)	0.59	2
Soil/Dust		
Concentration		
Soil	200	104.1
Dust	200	104.1
Soil ingestion as percent of total soil and dust ingestion	45	45
Soil/Dust lead concentration (μg/g)		
Age =		
0-1 year (0-11 mo)	0.085	0.085
1-2 years (12-23 mo)	0.135	0.135
2-3 years (24-35 mo)	0.135	0.135
3-4 years (36-47 mo)	0.135	0.135
4-5 years (48-59 mo)	0.100	0.100
5-6 years (60-71 mo)	0.090	0.090
6-7 years (72-84 mo)	0.085	0.085
Dust lead concentration (μg/g)		
Age =	0.0	0.0
1-2 years (12-23 mo)	0.0	0.0
2-3 years (24-35 mo)	0.0	0.0
3-4 years (36-47 mo)	0.0	0.0
4-5 years (48-59 mo)	0.0	0.0
5-6 years (60-71 mo)	0.0	0.0
6-7 years (72-84 mo)	0.0	0.0

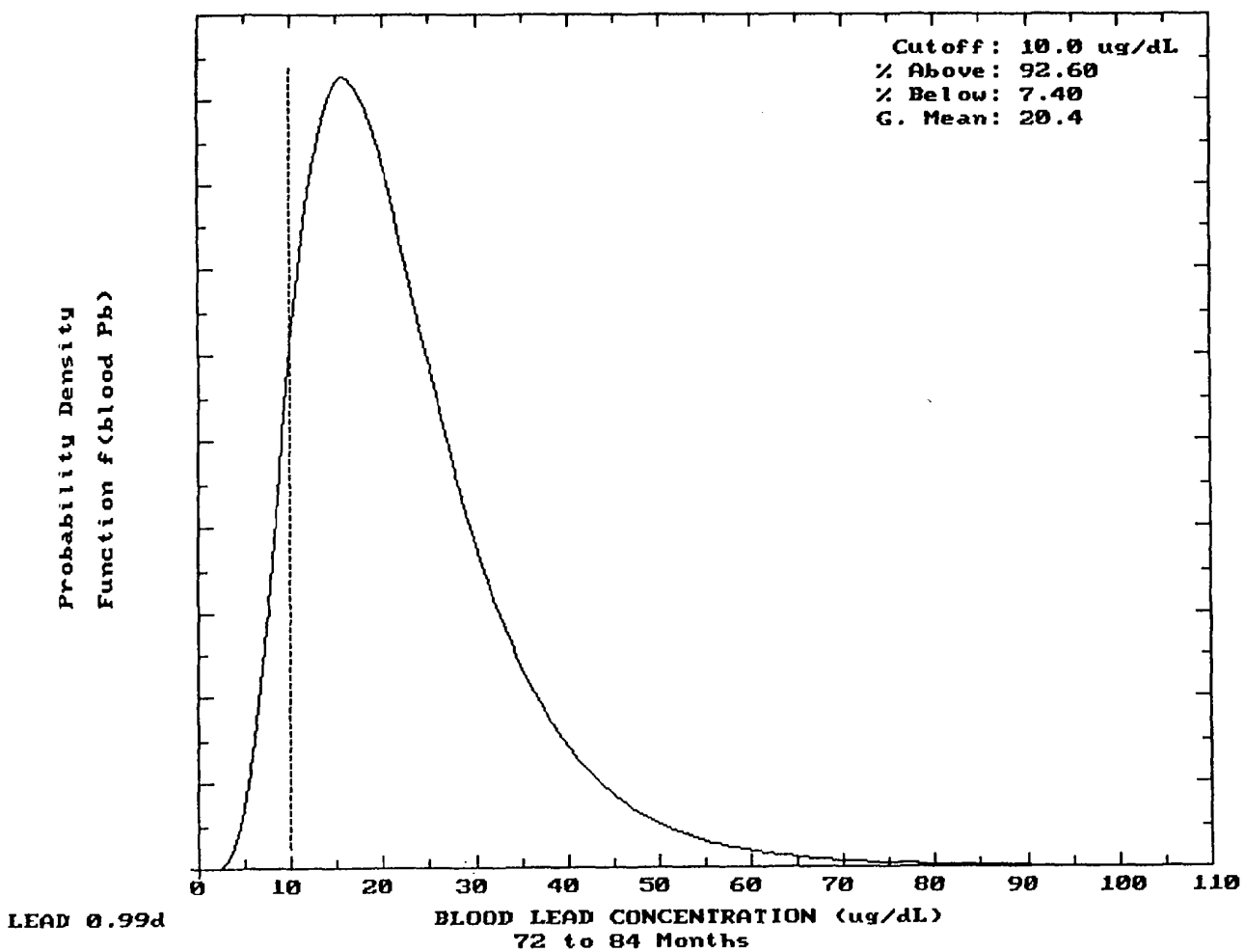
IEUBK MODEL OPTIONS

SITE - 7 (Continued)

Parameter	Default Option	User Defined Option
Bioavailability For All Gut Absorption Pathways		
Total lead Absorption (at low intake)		
diet	50	50
drinking water	50	50
soil	30	30
dust	30	30
alternate source	0	0
Fraction of lead absorbed at high intake		
diet	0.2	0.2
drinking water	0.2	0.2
soil	0.2	0.2
dust	0.2	0.2
alternate source	0.2	0.2
Maternal-to-Newborn Lead Exposure		
Mother's blood lead level at time of birth	2.5	2.5
Geometric standard deviation for blood lead (GSD)	1.6	1.6
Blood lead level of concern	10	10


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 20.4
Intersect: 92.60 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
72 to 84 Months

Site 7



Site 7
Figure N-2

SITE - 9

CONSTITUENTS DETECTED IN SURFACE SOIL SAMPLES
SITE 9
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)	Residential Soil Concentration (ug/kg) [a]	Potential Concern
VOLATILES				
Acetone	4 / 6	14 j	7.80E+05	NO
Toluene	5 / 6	3 – 19	1.60E+06	NO
SEMI–VOLATILES				
Fluoranthene	1 / 6	52 j	3.10E+05	NO
Pyrene	2 / 6	37 – 75 j	2.30E+05	NO
Chrysene	1 / 6	47 j	8.80E+04	NO
Benzo (b) fluoranthene	1 / 6	57 j	8.80E+02	NO
PCBs & PESTICIDES				
Dieldrin	1 / 6	4.8	4.00E+01	NO
4,4'–DDE	2 / 6	8.2 – 13 j	1.90E+03	NO
Endrin	1 / 6	3.8	2.30E+03	NO
4,4'–DDD	4 / 6	5 – 18	2.70E+03	NO
4,4'–DDT	3 / 6	5.8 – 13 j	1.90E+03	NO
Alpha–chlordane	2 / 6	2.8 – 8.5 j	4.90E+02	NO
Gamma–chlordane	1 / 6	9.9 j	4.90E+02	NO
Aroclor–1260	1 / 6	34 j	8.30E+01	YES

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

CONSTITUENTS DETECTED IN SURFACE SOIL SAMPLES
SITE 9
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)			Residential Soil Concentration (ug/kg) [a]	Potential Concern
INORGANICS						
Aluminum	6 / 6	847000	–	1E+07	2.30E+07	NO
Arsenic	6 / 6	610 b	–	3100	3.70E+02	YES
Barium	6 / 6	3100 b	–	58200	5.50E+05	NO
Beryllium [b]	4 / 6	230 b	–	340 b	1.50E+02	YES
Cadmium	1 / 6		530 b		3.90E+04	NO
Calcium	6 / 6	27500	–	6900000		NO
Chromium	6 / 6	6200	–	13500	3.90E+04	NO
Cobalt	5 / 6	970 b	–	3000 b	4.70E+05	NO
Copper	5 / 6	8100 j	–	24200 j	2.90E+05	NO
Iron	6 / 6	1180000 j	–	9290000 j		YES
Lead	6 / 6	9400 j	–	171000 j		YES *
Magnesium	6 / 6	84900	–	857000		NO
Manganese	6 / 6	4900 j	–	202000 j	3.90E+04	YES
Nickel	5 / 6	4900 b	–	6500 b	1.60E+05	NO
Potassium	6 / 6	66.2	–	547000		NO
Silver	1 / 6		880 j		3.90E+05	NO
Vanadium	6 / 6	3.7 b	–	18900 b	5.50E+04	NO
Zinc	5 / 6	27.9	–	84900	2.30E+06	YES

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum where it is obtained from the January 11, 1994 RBC Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

b. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor−1260	3.40E−02	200	1	14	6	1E−06	15	2190	25550	1.74E−08	1.49E−09	--	7.70E+00	--	1.15E−08	0.00%	3.66%
Arsenic	3.10E+00	200	1	14	6	1E−06	15	2190	25550	1.59E−06	1.36E−07	3.00E−04	1.75E+00	5.28E−03	2.38E−07	12.59%	75.89%
Beryllium	3.40E−01	200	1	14	6	1E−06	15	2190	25550	1.74E−07	1.49E−08	5.00E−03	4.30E+00	3.48E−05	6.41E−08	0.08%	20.45%
Iron	9.29E+03	200	1	14	6	1E−06	15	2190	25550	4.75E−03	4.07E−04	3.00E−01	--	1.58E−02	--	37.74%	0.00%
Manganese	2.02E+02	200	1	14	6	1E−06	15	2190	25550	1.03E−04	8.85E−06	5.00E−03	--	2.07E−02	--	49.24%	0.00%
Zinc	8.49E+01	200	1	14	6	1E−06	15	2190	25550	4.34E−05	3.72E−06	3.00E−01	--	1.45E−04	--	0.34%	0.00%
TOTAL														4.20E−02	3.13E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor−1260	3.40E−02	100	1	28	30	1E−06	70	10950	25550	3.73E−09	1.60E−09	--	7.70E+00	--	1.23E−08	0.00%	3.66%
Arsenic	3.10E+00	100	1	28	30	1E−06	70	10950	25550	3.40E−07	1.46E−07	3.00E−04	1.75E+00	1.13E−03	2.55E−07	12.59%	75.89%
Beryllium	3.40E−01	100	1	28	30	1E−06	70	10950	25550	3.73E−08	1.60E−08	5.00E−03	4.30E+00	7.45E−06	6.87E−08	0.08%	20.45%
Iron	9.29E+03	100	1	28	30	1E−06	70	10950	25550	1.02E−03	4.36E−04	3.00E−01	--	3.39E−03	--	37.74%	0.00%
Manganese	2.02E+02	100	1	28	30	1E−06	70	10950	25550	2.21E−05	9.49E−06	5.00E−03	--	4.43E−03	--	49.24%	0.00%
Zinc	8.49E+01	100	1	28	30	1E−06	70	10950	25550	9.30E−06	3.99E−06	3.00E−01	--	3.10E−05	--	0.34%	0.00%
TOTAL														8.99E−03	3.36E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL – INGESTION
RECREATIONAL CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor-1260	3.40E-02	67	1	14	6	1E-06	15	2190	25550	5.83E-09	4.99E-10	--	7.70E+00	--	3.84E-09	0.00%	3.66%
Arsenic	3.10E+00	67	1	14	6	1E-06	15	2190	25550	5.31E-07	4.55E-08	3.00E-04	1.75E+00	1.77E-03	7.97E-08	12.59%	75.89%
Beryllium	3.40E-01	67	1	14	6	1E-06	15	2190	25550	5.83E-08	4.99E-09	5.00E-03	4.30E+00	1.17E-05	2.15E-08	0.08%	20.45%
Iron	9.29E+03	67	1	14	6	1E-06	15	2190	25550	1.59E-03	1.36E-04	3.00E-01	--	5.31E-03	--	37.74%	0.00%
Manganese	2.02E+02	67	1	14	6	1E-06	15	2190	25550	3.46E-05	2.97E-06	5.00E-03	--	6.92E-03	--	49.24%	0.00%
Zinc	8.49E+01	67	1	14	6	1E-06	15	2190	25550	1.45E-05	1.25E-06	3.00E-01	--	4.85E-05	--	0.34%	0.00%
TOTAL														1.41E-02	1.05E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL – INGESTION
RECREATIONAL ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor−1260	3.40E−02	33	1	28	30	1E−06	70	10950	25550	1.23E−09	5.27E−10	--	7.70E+00	--	4.06E−09	0.00%	3.66%
Arsenic	3.10E+00	33	1	28	30	1E−06	70	10950	25550	1.12E−07	4.80E−08	3.00E−04	1.75E+00	3.74E−04	8.41E−08	12.59%	75.89%
Beryllium	3.40E−01	33	1	28	30	1E−06	70	10950	25550	1.23E−08	5.27E−09	5.00E−03	4.30E+00	2.46E−06	2.27E−08	0.08%	20.45%
Iron	9.29E+03	33	1	28	30	1E−06	70	10950	25550	3.36E−04	1.44E−04	3.00E−01	--	1.12E−03	--	37.74%	0.00%
Manganese	2.02E+02	33	1	28	30	1E−06	70	10950	25550	7.31E−06	3.13E−06	5.00E−03	--	1.46E−03	--	49.24%	0.00%
Zinc	8.49E+01	33	1	28	30	1E−06	70	10950	25550	3.07E−06	1.32E−06	3.00E−01	--	1.02E−05	--	0.34%	0.00%
TOTAL														2.97E−03	1.11E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL – INGESTION
WORKER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor−1260	3.40E−02	50	1	250	25	1E−06	70	9125	25550	1.66E−08	5.94E−09	--	7.70E+00	--	4.57E−08	0.00%	3.66%
Arsenic	3.10E+00	50	1	250	25	1E−06	70	9125	25550	1.52E−06	5.42E−07	3.00E−04	1.75E+00	5.06E−03	9.48E−07	12.59%	75.89%
Beryllium	3.40E−01	50	1	250	25	1E−06	70	9125	25550	1.66E−07	5.94E−08	5.00E−03	4.30E+00	3.33E−05	2.55E−07	0.08%	20.45%
Iron	9.29E+03	50	1	250	25	1E−06	70	9125	25550	4.55E−03	1.62E−03	3.00E−01	--	1.52E−02	--	37.74%	0.00%
Manganese	2.02E+02	50	1	250	25	1E−06	70	9125	25550	9.88E−05	3.53E−05	5.00E−03	--	1.98E−02	--	49.24%	0.00%
Zinc	8.49E+01	50	1	250	25	1E−06	70	9125	25550	4.15E−05	1.48E−05	3.00E−01	--	1.38E−04	--	0.34%	0.00%
TOTAL														4.01E−02	1.25E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL – DERMAL
TRESPASSER CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor-1260	3.40E-02	1820	1	0.06	14	6	1E-06	15	2190	25550	9.49E-09	8.14E-10	--	7.70E+00	--	6.27E-09	0.00%	69.52%
Arsenic	3.10E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.44E-08	1.24E-09	3.00E-04	1.75E+00	4.81E-05	2.16E-09	12.59%	24.01%
Beryllium	3.40E-01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.58E-09	1.36E-10	5.00E-03	4.30E+00	3.16E-07	5.83E-10	0.08%	6.47%
Iron	9.29E+03	1820	1	0.001	14	6	1E-06	15	2190	25550	4.32E-05	3.71E-06	3.00E-01	--	1.44E-04	–	37.74%	0.00%
Manganese	2.02E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	9.40E-07	8.06E-08	5.00E-03	--	1.88E-04	–	49.24%	0.00%
Zinc	8.49E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	3.95E-07	3.39E-08	3.00E-01	--	1.32E-06	–	0.34%	0.00%
TOTAL															3.82E-04	9.01E-09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL – DERMAL
TRESPASSER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor-1260	3.40E-02	5800	1	0.06	28	30	1E-06	70	10950	25550	1.30E-08	5.56E-09	--	7.70E+00	--	4.28E-08	0.00%	69.52%
Arsenic	3.10E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	1.97E-08	8.44E-09	3.00E-04	1.75E+00	6.57E-05	1.48E-08	12.59%	24.01%
Beryllium	3.40E-01	5800	1	0.001	28	30	1E-06	70	10950	25550	2.16E-09	9.26E-10	5.00E-03	4.30E+00	4.32E-07	3.98E-09	0.08%	6.47%
Iron	9.29E+03	5800	1	0.001	28	30	1E-06	70	10950	25550	5.90E-05	2.53E-05	3.00E-01	--	1.97E-04	–	37.74%	0.00%
Manganese	2.02E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	1.28E-06	5.50E-07	5.00E-03	--	2.57E-04	–	49.24%	0.00%
Zinc	8.49E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	5.40E-07	2.31E-07	3.00E-01	--	1.80E-06	–	0.34%	0.00%
TOTAL															5.22E-04	6.16E-08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL – DERMAL
RECREATIONAL CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor-1260	3.40E-02	1820	1	0.06	14	6	1E-06	15	2190	25550	9.49E-09	8.14E-10	--	7.70E+00	--	6.27E-09	0.00%	69.52%
Arsenic	3.10E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.44E-08	1.24E-09	3.00E-04	1.75E+00	4.81E-05	2.16E-09	12.59%	24.01%
Beryllium	3.40E-01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.58E-09	1.36E-10	5.00E-03	4.30E+00	3.16E-07	5.83E-10	0.08%	6.47%
Iron	9.29E+03	1820	1	0.001	14	6	1E-06	15	2190	25550	4.32E-05	3.71E-06	3.00E-01	--	1.44E-04	-	37.74%	0.00%
Manganese	2.02E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	9.40E-07	8.06E-08	5.00E-03	--	1.88E-04	-	49.24%	0.00%
Zinc	8.49E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	3.95E-07	3.39E-08	3.00E-01	--	1.32E-06	-	0.34%	0.00%
TOTAL															3.82E-04	9.01E-09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL -- DERMAL
RECREATIONAL ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor-1260	3.40E-02	5800	1	0.06	28	30	1E-06	70	10950	25550	1.30E-08	5.56E-09	--	7.70E+00	--	4.28E-08	0.00%	69.52%
Arsenic	3.10E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	1.97E-08	8.44E-09	3.00E-04	1.75E+00	6.57E-05	1.48E-08	12.59%	24.01%
Beryllium	3.40E-01	5800	1	0.001	28	30	1E-06	70	10950	25550	2.16E-09	9.26E-10	5.00E-03	4.30E+00	4.32E-07	3.98E-09	0.08%	6.47%
Iron	9.29E+03	5800	1	0.001	28	30	1E-06	70	10950	25550	5.90E-05	2.53E-05	3.00E-01	--	1.97E-04	-	37.74%	0.00%
Manganese	2.02E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	1.28E-06	5.50E-07	5.00E-03	--	2.57E-04	-	49.24%	0.00%
Zinc	8.49E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	5.40E-07	2.31E-07	3.00E-01	--	1.80E-06	-	0.34%	0.00%
TOTAL															5.22E-04	6.16E-08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 9

CURRENT SCENARIO
SOIL – DERMAL
WORKER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor-1260	3.40E-02	5800	1	0.06	250	25	1E-06	70	9125	25550	1.16E-07	4.13E-08	--	7.70E+00	--	3.18E-07	0.00%	69.52%
Arsenic	3.10E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	1.76E-07	6.28E-08	3.00E-04	1.75E+00	5.86E-04	1.10E-07	12.59%	24.01%
Beryllium	3.40E-01	5800	1	0.001	250	25	1E-06	70	9125	25550	1.93E-08	6.89E-09	5.00E-03	4.30E+00	3.86E-06	2.96E-08	0.08%	6.47%
Iron	9.29E+03	5800	1	0.001	250	25	1E-06	70	9125	25550	5.27E-04	1.88E-04	3.00E-01	--	1.76E-03	–	37.74%	0.00%
Manganese	2.02E+02	5800	1	0.001	250	25	1E-06	70	9125	25550	1.15E-05	4.09E-06	5.00E-03	--	2.29E-03	–	49.24%	0.00%
Zinc	8.49E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	4.82E-06	1.72E-06	3.00E-01	--	1.61E-05	–	0.34%	0.00%
TOTAL															4.66E-03	4.58E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 9

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor−1260	3.40E−02	200	1	350	6	1E−06	15	2190	25550	4.35E−07	3.73E−08	--	7.70E+00	--	2.87E−07	0.00%	3.66%
Arsenic	3.10E+00	200	1	350	6	1E−06	15	2190	25550	3.96E−05	3.40E−06	3.00E−04	1.75E+00	1.32E−01	5.95E−06	12.59%	75.89%
Beryllium	3.40E−01	200	1	350	6	1E−06	15	2190	25550	4.35E−06	3.73E−07	5.00E−03	4.30E+00	8.69E−04	1.60E−06	0.08%	20.45%
Iron	9.29E+03	200	1	350	6	1E−06	15	2190	25550	1.19E−01	1.02E−02	3.00E−01	--	3.96E−01	--	37.74%	0.00%
Manganese	2.02E+02	200	1	350	6	1E−06	15	2190	25550	2.58E−03	2.21E−04	5.00E−03	--	5.17E−01	--	49.24%	0.00%
Zinc	8.49E+01	200	1	350	6	1E−06	15	2190	25550	1.09E−03	9.30E−05	3.00E−01	--	3.62E−03	--	0.34%	0.00%
TOTAL														1.05E+00	7.83E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 9

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor−1260	3.40E−02	100	1	350	30	1E−06	70	10950	25550	4.66E−08	2.00E−08	--	7.70E+00	--	1.54E−07	0.00%	3.66%
Arsenic	3.10E+00	100	1	350	30	1E−06	70	10950	25550	4.25E−06	1.82E−06	3.00E−04	1.75E+00	1.42E−02	3.18E−06	12.59%	75.89%
Beryllium	3.40E−01	100	1	350	30	1E−06	70	10950	25550	4.66E−07	2.00E−07	5.00E−03	4.30E+00	9.32E−05	8.58E−07	0.08%	20.45%
Iron	9.29E+03	100	1	350	30	1E−06	70	10950	25550	1.27E−02	5.45E−03	3.00E−01	--	4.24E−02	--	37.74%	0.00%
Manganese	2.02E+02	100	1	350	30	1E−06	70	10950	25550	2.77E−04	1.19E−04	5.00E−03	--	5.53E−02	--	49.24%	0.00%
Zinc	8.49E+01	100	1	350	30	1E−06	70	10950	25550	1.16E−04	4.98E−05	3.00E−01	--	3.88E−04	--	0.34%	0.00%
TOTAL														1.12E−01	4.20E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 9

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor−1260	3.40E−02	1820	1	0.06	350	6	1E−06	15	2190	25550	2.37E−07	2.03E−08	--	7.70E+00	--	1.57E−07	0.00%	69.52%
Arsenic	3.10E+00	1820	1	0.001	350	6	1E−06	15	2190	25550	3.61E−07	3.09E−08	3.00E−04	1.75E+00	1.20E−03	5.41E−08	12.59%	24.01%
Beryllium	3.40E−01	1820	1	0.001	350	6	1E−06	15	2190	25550	3.96E−08	3.39E−09	5.00E−03	4.30E+00	7.91E−06	1.46E−08	0.08%	6.47%
Iron	9.29E+03	1820	1	0.001	350	6	1E−06	15	2190	25550	1.08E−03	9.26E−05	3.00E−01	--	3.60E−03	–	37.74%	0.00%
Manganese	2.02E+02	1820	1	0.001	350	6	1E−06	15	2190	25550	2.35E−05	2.01E−06	5.00E−03	--	4.70E−03	–	49.24%	0.00%
Zinc	8.49E+01	1820	1	0.001	350	6	1E−06	15	2190	25550	9.88E−06	8.47E−07	3.00E−01	--	3.29E−05	–	0.34%	0.00%
TOTAL															9.55E−03	2.25E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 9

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Aroclor-1260	3.40E-02	5800	1	0.06	350	30	1E-06	70	10950	25550	1.62E-07	6.95E-08	--	7.70E+00	--	5.35E-07	0.00%	69.52%
Arsenic	3.10E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	2.46E-07	1.06E-07	3.00E-04	1.75E+00	8.21E-04	1.85E-07	12.59%	24.01%
Beryllium	3.40E-01	5800	1	0.001	350	30	1E-06	70	10950	25550	2.70E-08	1.16E-08	5.00E-03	4.30E+00	5.40E-06	4.98E-08	0.08%	6.47%
Iron	9.29E+03	5800	1	0.001	350	30	1E-06	70	10950	25550	7.38E-04	3.16E-04	3.00E-01	--	2.46E-03	--	37.74%	0.00%
Manganese	2.02E+02	5800	1	0.001	350	30	1E-06	70	10950	25550	1.60E-05	6.88E-06	5.00E-03	--	3.21E-03	--	49.24%	0.00%
Zinc	8.49E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	6.75E-06	2.89E-06	3.00E-01	--	2.25E-05	--	0.34%	0.00%
TOTAL															6.52E-03	7.69E-07	100.00%	100.00%

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 9
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)			Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
INORGANICS									
Aluminum	4 / 4	115 j	–	6790.0 j		11000			NO
Arsenic [e]	3 / 4	5.4 j	–	7.9 b	0.018	0.038	50	50	YES
Barium	4 / 4	22 b	–	371.0		260	2000	1000	YES
Cadmium	1 / 4	4.8 j				18	5	0.4	NO
Calcium	4 / 4	2990	–	130000.0					NO
Chromium	2 / 4	13.9	–	14.2		18	100	50	NO
Cobalt [e]	4 / 4	3.3 b	–	3.4 b		220			NO
Copper [e]	4 / 4	5 b	–	17.4 b		140	1300	1000	NO
Iron	4 / 4	4240.0	–	21600.0					YES
Lead	3 / 4	6.1 j	–	10.8 j				50	YES*
Magnesium	4 / 4	1250	–	17600.0					NO
Manganese	4 / 4	48.4	–	334.0		18			NO
Potassium	4 / 4	1890	–	12300.0	610	73	100		NO
Sodium	4 / 4	3420	–	1.6E+04				270000	NO
Vanadium [e]	2 / 4	18.9 b	–	21.3 b		26			NO
Zinc	4 / 4	50	–	453.0		1100		50	YES
ANIONS									
Alkalinity	4 / 4	21000.0	–	420000.0				30000	YES
Bicarbonate alkalinity	4 / 4	21000.0	–	420000.0					YES
Chloride	4 / 4	6300.0	–	20200.0				50000	NO
Sulfate	4 / 4	7900.0	–	23600.0				50000	NO

Notes:

a. Federal MCL concentration values represent US Federal Contaminant Level for potable water supplies

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the Januray 7, 1994 RBC Table using a target hazard quotient of 0.1.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

e. Constituent concentration is five times greater than the maximum detected in blank (b).

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 9

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	7.90E+00	1	14	6	1E−03	15	2190	25550	2.02E−05	1.73E−06	3.00E−04	1.75E+00	6.73E−02	3.03E−06	25.05%	100.00%
Barium	3.71E+02	1	14	6	1E−03	15	2190	25550	9.49E−04	8.13E−05	7.00E−02	--	1.36E−02	--	5.04%	0.00%
Iron	2.16E+04	1	14	6	1E−03	15	2190	25550	5.52E−02	4.73E−03	3.00E−01	--	1.84E−01	--	68.48%	0.00%
Zinc	4.53E+02	1	14	6	1E−03	15	2190	25550	1.16E−03	9.93E−05	3.00E−01	--	3.86E−03	--	1.44%	0.00%
TOTAL													2.69E−01	3.03E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 9

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	7.90E+00	2	28	30	1E−06	70	10950	25550	1.73E−08	7.42E−09	3.00E−04	1.75E+00	5.77E−05	1.30E−08	25.05%	100.00%
Barium	3.71E+02	2	28	30	1E−06	70	10950	25550	8.13E−07	3.48E−07	7.00E−02	--	1.16E−05	--	5.04%	0.00%
Iron	2.16E+04	2	28	30	1E−06	70	10950	25550	4.73E−05	2.03E−05	3.00E−01	--	1.58E−04	--	68.46%	0.00%
Zinc	4.53E+02	2	28	30	1E−06	70	10950	25550	9.93E−07	4.26E−07	3.00E−01	--	3.31E−06	--	1.44%	0.00%
TOTAL													2.30E−04	1.30E−08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 9

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	7.90E+00	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	1.47E-07	1.26E-08	3.00E-04	1.75E+00	4.90E-04	2.21E-08	25.19%	100.00%
Barium	3.71E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	6.91E-06	5.92E-07	7.00E-02	--	9.87E-05	–	5.07%	0.00%
Iron	2.16E+04	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	4.02E-04	3.45E-05	3.00E-01	--	1.34E-03	–	68.87%	0.00%
Zinc	4.53E+02	7280	0.0006 *	0.2	14	6	1E-06	15	2190	25550	5.06E-06	4.34E-07	3.00E-01	--	1.69E-05	–	0.87%	0.00%
TOTAL															1.95E-03	2.21E-08	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 9

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	7.90E+00	23000	0.001 ***	0.2	28	30	1E−06	70	10950	25550	1.99E−07	8.53E−08	3.00E−04	1.75E+00	6.64E−04	1.49E−07	25.19%	100.00%
Barium	3.71E+02	23000	0.001 ***	0.2	28	30	1E−06	70	10950	25550	9.35E−06	4.01E−06	7.00E−02	--	1.34E−04	–	5.07%	0.00%
Iron	2.16E+04	23000	0.001 ***	0.2	28	30	1E−06	70	10950	25550	5.44E−04	2.33E−04	3.00E−01	--	1.81E−03	–	68.87%	0.00%
Zinc	4.53E+02	23000	0.0006 *	0.2	28	30	1E−06	70	10950	25550	6.85E−06	2.94E−06	3.00E−01	--	2.28E−05	–	0.87%	0.00%
TOTAL															2.63E−03	1.49E−07	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 9
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)			Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
DISSOLVED METALS:									
INORGANICS									
Aluminum	1 / 4		766.0			11000			NO
Arsenic [e]	1 / 4		4.0 b		0.018	0.038	50	50	YES
Barium	4 / 4	18.5 b	–	339.0		260	2000	1000	YES
Cadmium	1 / 4		4.0 b			18	5	0.4	NO
Calcium	4 / 4	2650 b	–	122000.0					NO
Chromium	1 / 4		7.3 b			18	100	50	NO
Cobalt [e]	2 / 4	3.3 b	–	3.4 b		220			NO
Iron	4 / 4	190	–	18900.0					YES
Magnesium	4 / 4	1390	–	16600.0					NO
Manganese	4 / 4	9.5 b	–	312.0		18			NO
Potassium	4 / 4	1200	–	11500.0	610	73	100		NO
Sodium	4 / 4	3520	–	1.5E+04				270000	NO
Zinc	4 / 4	25.5	–	421.0		1100		50	YES

Notes:

a. Federal MCL concentration values represent US Federal Contaminant Level for potable water supplies

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the Januray 7, 1994 RBC Table using a target hazard quotient of 0.1.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

e. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 9

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
DISSOLVED METALS:																
Arsenic	4.00E+00	1	14	6	1E−03	15	2190	25550	1.02E−05	8.77E−07	3.00E−04	1.75E+00	3.41E−02	1.53E−06	16.15%	100.00%
Barium	3.39E+02	1	14	6	1E−03	15	2190	25550	8.67E−04	7.43E−05	7.00E−02	--	1.24E−02	--	5.86%	0.00%
Iron	1.89E+04	1	14	6	1E−03	15	2190	25550	4.83E−02	4.14E−03	3.00E−01	--	1.61E−01	--	76.29%	0.00%
Zinc	4.21E+02	1	14	6	1E−03	15	2190	25550	1.08E−03	9.23E−05	3.00E−01	--	3.59E−03	--	1.70%	0.00%
TOTAL													2.11E−01	1.53E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 9

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
DISSOLVED METALS:																
Arsenic	4.00E+00	2	28	30	1E−06	70	10950	25550	8.77E−09	3.76E−09	3.00E−04	1.75E+00	2.92E−05	6.58E−09	16.15%	100.00%
Barium	3.39E+02	2	28	30	1E−06	70	10950	25550	7.43E−07	3.18E−07	7.00E−02	--	1.06E−05	--	5.86%	0.00%
Iron	1.89E+04	2	28	30	1E−06	70	10950	25550	4.14E−05	1.78E−05	3.00E−01	--	1.38E−04	--	76.29%	0.00%
Zinc	4.21E+02	2	28	30	1E−06	70	10950	25550	9.23E−07	3.95E−07	3.00E−01	--	3.08E−06	--	1.70%	0.00%
TOTAL													1.81E−04	6.58E−09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 9

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
DISSOLVED METALS:																		
Arsenic	4.00E+00	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	7.45E-08	6.38E-09	3.00E-04	1.75E+00	2.48E-04	1.12E-08	16.26%	100.00%
Barium	3.39E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	6.31E-06	5.41E-07	7.00E-02	--	9.02E-05	–	5.90%	0.00%
Iron	1.89E+04	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	3.52E-04	3.02E-05	3.00E-01	--	1.17E-03	–	76.81%	0.00%
Zinc	4.21E+02	7280	0.0006 *	0.2	14	6	1E-06	15	2190	25550	4.70E-06	4.03E-07	3.00E-01	--	1.57E-05	–	1.03%	0.00%
TOTAL															1.53E-03	1.12E-08	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 9

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
DISSOLVED METALS:																		
Arsenic	4.00E+00	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	1.01E-07	4.32E-08	3.00E-04	1.75E+00	3.36E-04	7.56E-08	16.26%	100.00%
Barium	3.39E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	8.54E-06	3.66E-06	7.00E-02	--	1.22E-04	–	5.90%	0.00%
Iron	1.89E+04	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	4.76E-04	2.04E-04	3.00E-01	--	1.59E-03	–	76.81%	0.00%
Zinc	4.21E+02	23000	0.0006 *	0.2	28	30	1E-06	70	10950	25550	6.37E-06	2.73E-06	3.00E-01	--	2.12E-05	–	1.03%	0.00%
TOTAL															2.07E-03	7.56E-08	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

IEUBK MODEL OPTIONS
SITE - 9

Parameter	Default Option	User Defined Option
Air		
Outdoor air lead concentration ($\mu g/m^3$)	0.10	0.00
Ratio of indoor to outdoor air lead concentration (%)	30	00
Time outdoors (hours/day)		
Age =		
0-1 year (0-11 mo)	1	1
1-2 years (12-23 mo)	2	2
2-3 years (24-35 mo)	3	3
3-7 years (36-83 mo)	4	4
Ventilation rate (m^2/day)		
Age =		
0-1 year (0-11 mo)	2	2
1-2 years (12-23 mo)	3	3
2-3 years (24-35 mo)	5	5
3-4 years (36-47 mo)	5	5
4-5 years (48-59 mo)	5	5
5-6 years (60-71 mo)	7	7
6-7 years (72-84 mo)	7	7
Lung absorption (%)	32	00
Dietary lead intake ($\mu g/m^3$)		
Age =		
0-1 year (0-11 mo)	5.53	0.00
1-2 years (12-23 mo)	5.78	0.00
2-3 years (24-35 mo)	6.49	0.00
3-4 years (36-47 mo)	6.24	0.00
4-5 years (48-59 mo)	6.01	0.00
5-6 years (60-71 mo)	6.34	0.00
6-7 years (72-84 mo)	7.00	0.00
Alternate Diet Sources		
Concentration (μg Pb/g)		
home-grown fruits		
home-grown vegetables	0	0.000
fish from fishing	0	0.000
game from hunting	0	0.000
	0	0.000
Percent of food class (%)		
home-grown fruits	0	0
home-grown vegetables	0	0
fish from fishing	0	0
game from hunting	0	0

IEUBK MODEL OPTIONS

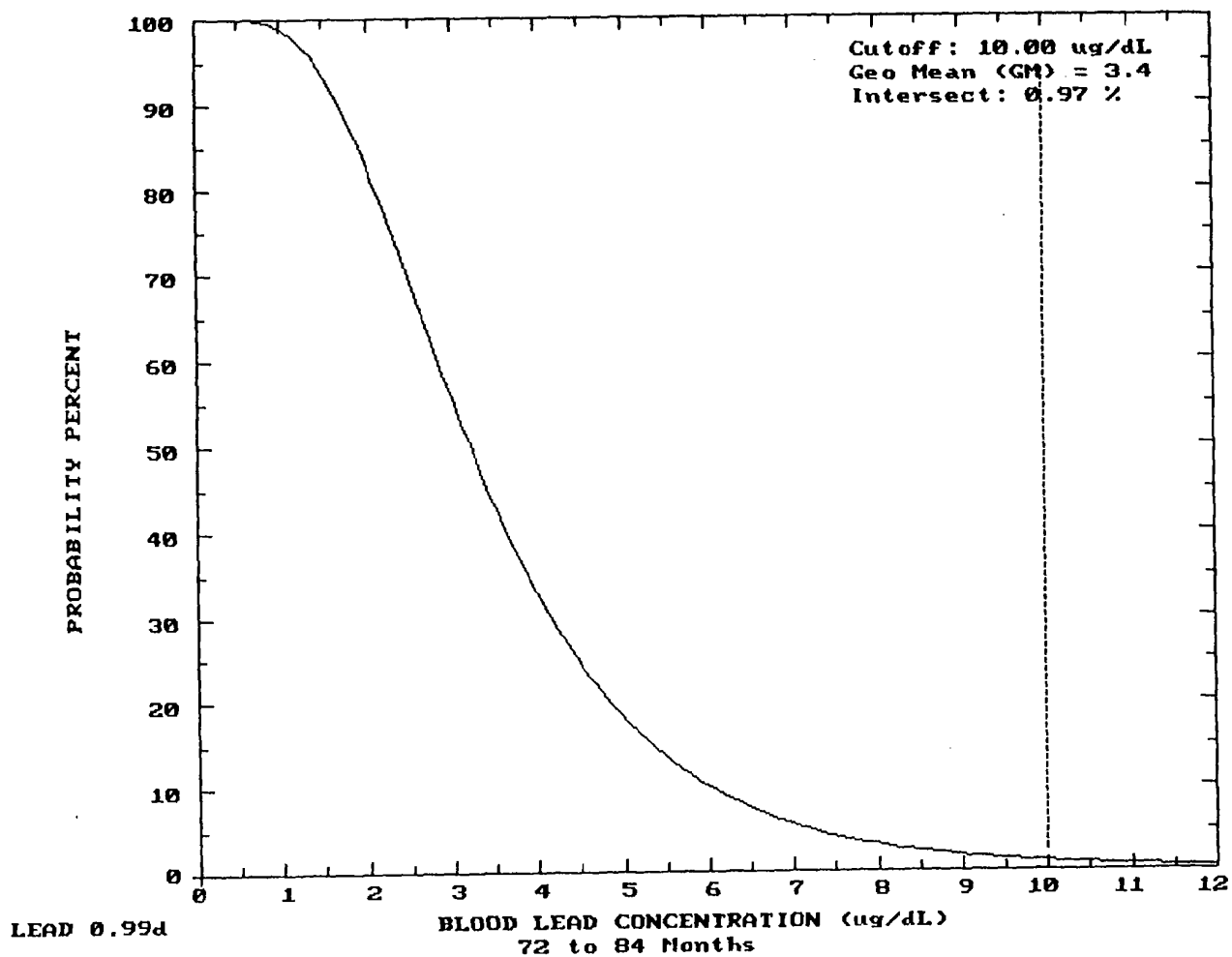
SITE - 9 (Continued)

Parameter	Default Option	User Defined Option
Drinking Water		
Lead concentration in drinking water (μg/L)	4	7.9
Ingestion rate (liters/day)		
Age =		
0-1 year (0-11 mo)	0.20	2
1-2 years (12-23 mo)	0.50	2
2-3 years (24-35 mo)	0.52	2
3-4 years (36-47 mo)	0.53	2
4-5 years (48-59 mo)	0.55	2
5-6 years (60-71 mo)	0.58	2
6-7 years (72-84 mo)	0.59	2
Soil/Dust		
Concentration		
Soil	200	45.3
Dust	200	45.3
Soil ingestion as percent of total soil and dust ingestion	45	45
Soil/Dust lead concentration (μg/g)		
Age =		
0-1 year (0-11 mo)	0.085	0.085
1-2 years (12-23 mo)	0.135	0.135
2-3 years (24-35 mo)	0.135	0.135
3-4 years (36-47 mo)	0.135	0.135
4-5 years (48-59 mo)	0.100	0.100
5-6 years (60-71 mo)	0.090	0.090
6-7 years (72-84 mo)	0.085	0.085
Dust lead concentration (μg/g)		
Age =	0.0	0.0
1-2 years (12-23 mo)	0.0	0.0
2-3 years (24-35 mo)	0.0	0.0
3-4 years (36-47 mo)	0.0	0.0
4-5 years (48-59 mo)	0.0	0.0
5-6 years (60-71 mo)	0.0	0.0
6-7 years (72-84 mo)	0.0	0.0

IEUBK MODEL OPTIONS

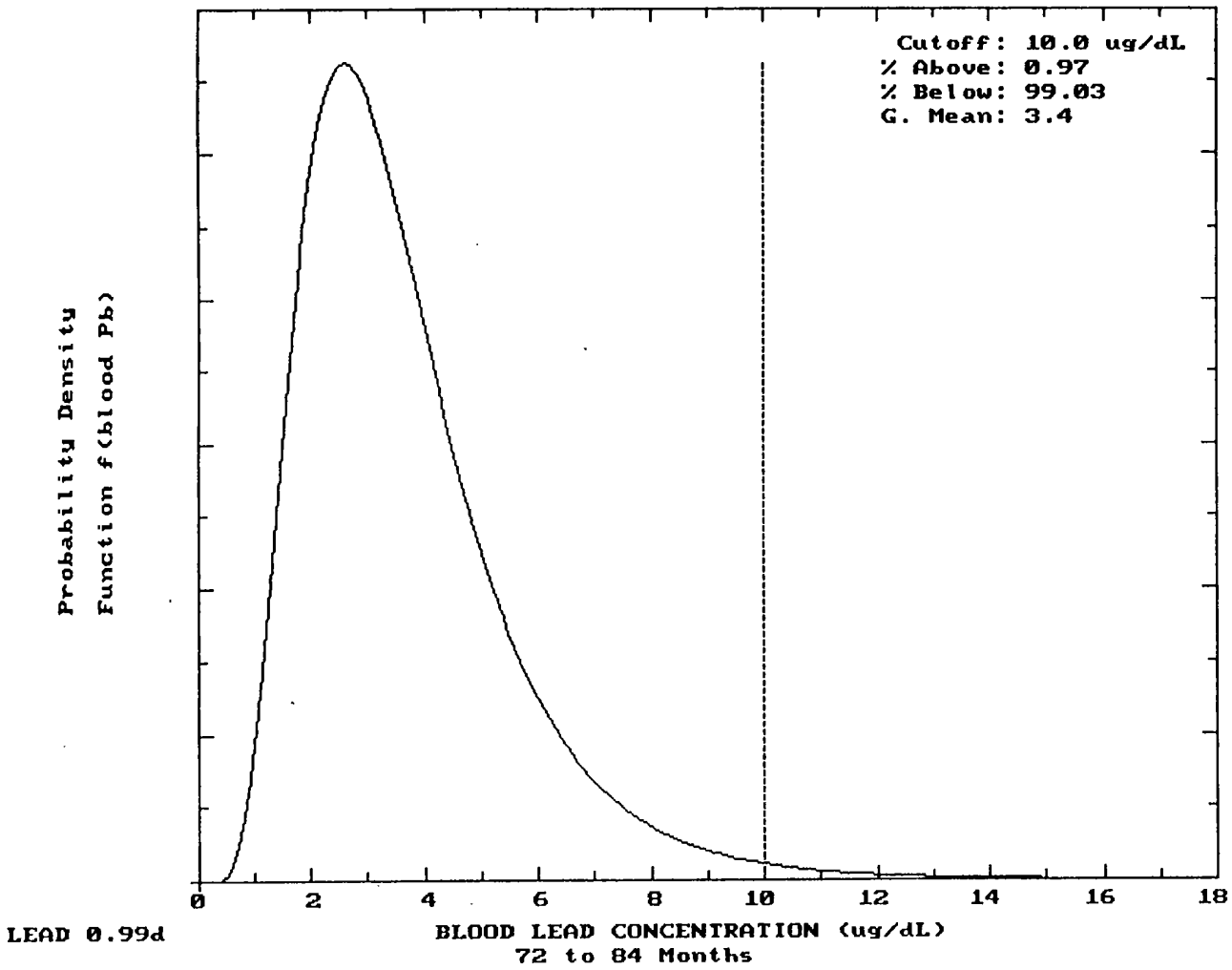
SITE - 9 (Continued)

Parameter	Default Option	User Defined Option
Bioavailability For All Gut Absorption Pathways		
Total lead Absorption (at low intake)		
diet	50	50
drinking water	50	50
soil	30	30
dust	30	30
alternate source	0	0
Fraction of lead absorbed at high intake		
diet	0.2	0.2
drinking water	0.2	0.2
soil	0.2	0.2
dust	0.2	0.2
alternate source	0.2	0.2
Maternal-to-Newborn Lead Exposure		
Mother's blood lead level at time of birth	2.5	2.5
Geometric standard deviation for blood lead (GSD)	1.6	1.6
Blood lead level of concern	10	10



LEAD 0.99d

Site 9


Cutoff: 10.0 ug/dL
% Above: 0.97
% Below: 99.03
G. Mean: 3.4
Probability Density
Function f(blood Pb)
0
2
4
6
8
10
12
14
16
18
LEAD 0.99d
BLOOD LEAD CONCENTRATION (ug/dL)
72 to 84 Months

Site 9

SITE - 10

CONSTITUENTS DETECTED IN SURFACE SOIL SAMPLES
SITE 10
NAVAL AMPHIBIOUS BASES – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (mg/kg)			Residential Soil Concentration (mg/kg) [a]	Potenti Concer
VOLATILES						
Acetone	7 / 8	0.019	–	0.027	7.80E+02	NO
Toluene	5 / 8	0.001 j	–	0.015	1.60E+03	NO
SEMI–VOLATILES						
Fluoranthene	1 / 8		0.041 j		3.10E+02	NO
Pyrene	1 / 8		0.059 j		2.30E+02	NO
Benzo(b)fluoranthene	1 / 8		0.037 j		8.80E–01	NO
PCBs & PESTICIDES						
Dieldrin	1 / 8		0.035		4.00E–02	NO
4,4'–DDE	1 / 8		0.041		1.90E+00	NO
4,4'–DDD	2 / 8	0.0041 j	–	0.005	2.70E+00	NO
4,4'–DDT	1 / 8		0.045		1.90E+00	NO
Alpha–chlordane	4 / 8	0.0024 j	–	0.023	4.90E–01	NO
Gamma–chlordane	3 / 8	0.0025 j	–	0.0093	4.90E–01	NO
INORGANICS						
Aluminum	8 / 8	1240	–	9040	2.30E+04	NO
Arsenic	8 / 8	0.8 b	–	4	3.70E–01	YES
Barium	8 / 8	10.3 b	–	28.4	5.50E+02	NO
Calcium	8 / 8	250 b	–	1730		NO
Chromium	8 / 8	2.9	–	9.7	3.90E+01	NO
Cobalt	7 / 8	0.60 b	–	2	4.70E+02	NO
Copper	8 / 8	3.2 b	–	16.9	2.90E+02	NO
Iron	8 / 8	2770	–	10900		YES
Lead	8 / 8	1.8	–	19.7		YES *
Magnesium	8 / 8	211 b	–	1540		NO
Manganese	8 / 8	16 j	–	131	3.90E+01	YES
Nickel	7 / 8	3.0 b	–	5.8	1.60E+02	YES
Potassium	8 / 8	178 b	–	1790		NO
Vanadium	8 / 8	2.7 b	–	16.6	5.50E+01	NO
Zinc	8 / 8	15.1	–	65.2	2.30E+03	YES

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum where it is obtained from the January 11, 1994 RBC Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	200	1	14	6	1E−06	15	2190	25550	2.05E−06	1.75E−07	3.00E−04	1.75E+00	6.82E−03	3.07E−07	26.57%	100.00%
Iron	1.09E+04	200	1	14	6	1E−06	15	2190	25550	5.57E−03	4.78E−04	3.00E−01	--	1.86E−02	--	72.41%	0.00%
Nickel	5.80E+00	200	1	14	6	1E−06	15	2190	25550	2.97E−06	2.54E−07	2.00E−02	--	1.48E−04	--	0.58%	0.00%
Zinc	6.52E+01	200	1	14	6	1E−06	15	2190	25550	3.33E−05	2.86E−06	3.00E−01	--	1.11E−04	--	0.43%	0.00%
TOTAL														2.57E−02	3.07E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	100	1	28	30	1E−06	70	10950	25550	4.38E−07	1.88E−07	3.00E−04	1.75E+00	1.46E−03	3.29E−07	26.57%	100.00%
Iron	1.09E+04	100	1	28	30	1E−06	70	10950	25550	1.19E−03	5.12E−04	3.00E−01	--	3.98E−03	--	72.41%	0.00%
Nickel	5.80E+00	100	1	28	30	1E−06	70	10950	25550	6.36E−07	2.72E−07	2.00E−02	--	3.18E−05	--	0.58%	0.00%
Zinc	6.52E+01	100	1	28	30	1E−06	70	10950	25550	7.15E−06	3.06E−06	3.00E−01	--	2.38E−05	--	0.43%	0.00%
TOTAL														5.50E−03	3.29E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL – INGESTION
RECREATIONAL CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	67	1	14	6	1E−06	15	2190	25550	6.85E−07	5.87E−08	3.00E−04	1.75E+00	2.28E−03	1.03E−07	26.57%	100.00%
Iron	1.09E+04	67	1	14	6	1E−06	15	2190	25550	1.87E−03	1.60E−04	3.00E−01	--	6.22E−03	--	72.41%	0.00%
Nickel	5.80E+00	67	1	14	6	1E−06	15	2190	25550	9.94E−07	8.52E−08	2.00E−02	--	4.97E−05	--	0.58%	0.00%
Zinc	6.52E+01	67	1	14	6	1E−06	15	2190	25550	1.12E−05	9.57E−07	3.00E−01	--	3.72E−05	--	0.43%	0.00%
TOTAL														8.60E−03	1.03E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL – INGESTION
RECREATIONAL ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	33	1	28	30	1E−06	70	10950	25550	1.45E−07	6.20E−08	3.00E−04	1.75E+00	4.82E−04	1.08E−07	26.57%	100.00%
Iron	1.09E+04	33	1	28	30	1E−06	70	10950	25550	3.94E−04	1.69E−04	3.00E−01	--	1.31E−03	--	72.41%	0.00%
Nickel	5.80E+00	33	1	28	30	1E−06	70	10950	25550	2.10E−07	8.99E−08	2.00E−02	--	1.05E−05	--	0.58%	0.00%
Zinc	6.52E+01	33	1	28	30	1E−06	70	10950	25550	2.36E−06	1.01E−06	3.00E−01	--	7.86E−06	--	0.43%	0.00%
TOTAL														1.81E−03	1.08E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL – INGESTION
WORKER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	50	1	250	25	1E-06	70	9125	25550	1.96E-06	6.99E-07	3.00E-04	1.75E+00	6.52E-03	1.22E-06	26.57%	100.00%
Iron	1.09E+04	50	1	250	25	1E-06	70	9125	25550	5.33E-03	1.90E-03	3.00E-01	--	1.78E-02	--	72.41%	0.00%
Nickel	5.80E+00	50	1	250	25	1E-06	70	9125	25550	2.84E-06	1.01E-06	2.00E-02	--	1.42E-04	--	0.58%	0.00%
Zinc	6.52E+01	50	1	250	25	1E-06	70	9125	25550	3.19E-05	1.14E-05	3.00E-01	--	1.06E-04	--	0.43%	0.00%
TOTAL														2.45E-02	1.22E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL -- DERMAL
TRESPASSER CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.86E-08	1.60E-09	3.00E-04	1.75E+00	6.21E-05	2.79E-09	26.57%	100.00%
Iron	1.09E+04	1820	1	0.001	14	6	1E-06	15	2190	25550	5.07E-05	4.35E-06	3.00E-01	--	1.69E-04	-	72.41%	0.00%
Nickel	5.80E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	2.70E-08	2.31E-09	2.00E-02	--	1.35E-06	-	0.58%	0.00%
Zinc	6.52E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	3.03E-07	2.60E-08	3.00E-01	--	1.01E-06	-	0.43%	0.00%
TOTAL															2.34E-04	2.79E-09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL – DERMAL
TRESPASSER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	2.54E-08	1.09E-08	3.00E-04	1.75E+00	8.47E-05	1.91E-08	26.57%	100.00%
Iron	1.09E+04	5800	1	0.001	28	30	1E-06	70	10950	25550	6.93E-05	2.97E-05	3.00E-01	--	2.31E-04	–	72.41%	0.00%
Nickel	5.80E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	3.69E-08	1.58E-08	2.00E-02	--	1.84E-06	–	0.58%	0.00%
Zinc	6.52E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	4.14E-07	1.78E-07	3.00E-01	--	1.38E-06	–	0.43%	0.00%
TOTAL															3.19E-04	1.91E-08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL – DERMAL
RECREATIONAL CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.86E-08	1.60E-09	3.00E-04	1.75E+00	6.21E-05	2.79E-09	26.57%	100.00%
Iron	1.09E+04	1820	1	0.001	14	6	1E-06	15	2190	25550	5.07E-05	4.35E-06	3.00E-01	--	1.69E-04	–	72.41%	0.00%
Nickel	5.80E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	2.70E-08	2.31E-09	2.00E-02	--	1.35E-06	–	0.58%	0.00%
Zinc	6.52E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	3.03E-07	2.60E-08	3.00E-01	--	1.01E-06	–	0.43%	0.00%
TOTAL															2.34E-04	2.79E-09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL – DERMAL
RECREATIONAL ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	2.54E-08	1.09E-08	3.00E-04	1.75E+00	8.47E-05	1.91E-08	26.57%	100.00%
Iron	1.09E+04	5800	1	0.001	28	30	1E-06	70	10950	25550	6.93E-05	2.97E-05	3.00E-01	--	2.31E-04	–	72.41%	0.00%
Nickel	5.80E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	3.69E-08	1.58E-08	2.00E-02	--	1.84E-06	–	0.58%	0.00%
Zinc	6.52E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	4.14E-07	1.78E-07	3.00E-01	--	1.38E-06	–	0.43%	0.00%
TOTAL															3.19E-04	1.91E-08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 10

CURRENT SCENARIO
SOIL – DERMAL
WORKER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	2.27E-07	8.11E-08	3.00E-04	1.75E+00	7.57E-04	1.42E-07	26.57%	100.00%
Iron	1.09E+04	5800	1	0.001	250	25	1E-06	70	9125	25550	6.19E-04	2.21E-04	3.00E-01	--	2.06E-03	–	72.41%	0.00%
Nickel	5.80E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	3.29E-07	1.18E-07	2.00E-02	--	1.65E-05	–	0.58%	0.00%
Zinc	6.52E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	3.70E-06	1.32E-06	3.00E-01	--	1.23E-05	–	0.43%	0.00%
TOTAL															2.85E-03	1.42E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 10

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	200	1	350	6	1E−06	15	2190	25550	5.11E−05	4.38E−06	3.00E−04	1.75E+00	1.70E−01	7.67E−06	26.57%	100.00%
Iron	1.09E+04	200	1	350	6	1E−06	15	2190	25550	1.39E−01	1.19E−02	3.00E−01	--	4.65E−01	--	72.41%	0.00%
Nickel	5.80E+00	200	1	350	6	1E−06	15	2190	25550	7.42E−05	6.36E−06	2.00E−02	--	3.71E−03	--	0.58%	0.00%
Zinc	6.52E+01	200	1	350	6	1E−06	15	2190	25550	8.34E−04	7.15E−05	3.00E−01	--	2.78E−03	--	0.43%	0.00%
TOTAL														6.41E−01	7.67E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 10

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	100	1	350	30	1E-06	70	10950	25550	5.48E-06	2.35E-06	3.00E-04	1.75E+00	1.83E-02	4.11E-06	26.57%	100.00%
Iron	1.09E+04	100	1	350	30	1E-06	70	10950	25550	1.49E-02	6.40E-03	3.00E-01	--	4.98E-02	--	72.41%	0.00%
Nickel	5.80E+00	100	1	350	30	1E-06	70	10950	25550	7.95E-06	3.41E-06	2.00E-02	--	3.97E-04	--	0.58%	0.00%
Zinc	6.52E+01	100	1	350	30	1E-06	70	10950	25550	8.93E-05	3.83E-05	3.00E-01	--	2.98E-04	--	0.43%	0.00%
TOTAL														6.87E-02	4.11E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 10

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDinc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	4.65E-07	3.99E-08	3.00E-04	1.75E+00	1.55E-03	6.98E-08	26.57%	100.00%
Iron	1.09E+04	1820	1	0.001	350	6	1E-06	15	2190	25550	1.27E-03	1.09E-04	3.00E-01	--	4.23E-03	–	72.41%	0.00%
Nickel	5.80E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	6.75E-07	5.78E-08	2.00E-02	--	3.37E-05	–	0.58%	0.00%
Zinc	6.52E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	7.59E-06	6.50E-07	3.00E-01	--	2.53E-05	–	0.43%	0.00%
TOTAL															5.84E-03	6.98E-08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 10

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	4.00E+00	5800	1	0.001	350	30	1E−06	70	10950	25550	3.18E−07	1.36E−07	3.00E−04	1.75E+00	1.06E−03	2.38E−07	26.57%	100.00%
Iron	1.09E+04	5800	1	0.001	350	30	1E−06	70	10950	25550	8.66E−04	3.71E−04	3.00E−01	--	2.89E−03	–	72.41%	0.00%
Nickel	5.80E+00	5800	1	0.001	350	30	1E−06	70	10950	25550	4.61E−07	1.97E−07	2.00E−02	--	2.30E−05	–	0.58%	0.00%
Zinc	6.52E+01	5800	1	0.001	350	30	1E−06	70	10950	25550	5.18E−06	2.22E−06	3.00E−01	--	1.73E−05	–	0.43%	0.00%
TOTAL															3.99E−03	2.38E−07	100.00%	100.00%

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 10
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)	Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
ANIONS							
Alkalinity, Total	5 / 5	8000 – 197000				30000	YES
Alkalinity, Bicarbonate	5 / 5	8000 – 197000					YES
Chloride	5 / 5	8500 – 34000				50000	YES
Sulfate	4 / 5	6800 – 172000				50000	YES
INORGANICS							
Aluminum	5 / 5	536 – 4630 j		11000			NO
Arsenic	5 / 5	4.2 b – 21.2	0.018	0.038	50	50	YES
Barium [e]	5 / 5	23.6 b – 190 b		260	2000	1000	NO
Beryllium [e]	1 / 5	1.3 b		0.016	4		YES
Cadmium	2 / 5	4.6 j – 6.3 j		18	5	0.4	YES
Calcium	5 / 5	34300 – 86600					NO
Chromium [e]	3 / 5	6.5 b – 10 b		18	100	50	NO
Cobalt [e]	4 / 5	3.9 b – 25.2 b		220			NO
Copper	5 / 5	7.1 b – 26.7		140	1300	1000	NO
Iron	5 / 5	2020 – 108000					YES
Lead	5 / 5	2 j – 25				50	YES *
Magnesium	5 / 5	3420 j – 8940					NO
Manganese	5 / 5	113 – 1000		18			NO
Nickel	1 / 5	105	610	73	100		YES
Potassium	5 / 5	3520 b – 6790					NO
Sodium	5 / 5	4730 b – 24700				270000	NO
Vanadium	1 / 5	15 b		26			NO
Zinc	3 / 5	122 – 8490		1100		50	YES

Notes:

a. Federal MCL concentration values represent US Federal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the Januray 7, 1994 RBC Table using a target hazard quotient of 0.1.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

e. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 10

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	2.12E+01	1	14	6	1E-03	15	2190	25550	5.42E-05	4.65E-06	3.00E-04	1.75E+00	1.81E-01	8.13E-06	15.21%	86.91%
Beryllium	1.30E+00	1	14	6	1E-03	15	2190	25550	3.32E-06	2.85E-07	5.00E-03	4.30E+00	6.65E-04	1.23E-06	0.06%	13.09%
Iron	1.08E+05	1	14	6	1E-03	15	2190	25550	2.76E-01	2.37E-02	3.00E-01	--	9.21E-01	--	77.51%	0.00%
Nickel	1.05E+02	1	14	6	1E-03	15	2190	25550	2.68E-04	2.30E-05	2.00E-02	--	1.34E-02	--	1.13%	0.00%
Zinc	8.49E+03	1	14	6	1E-03	15	2190	25550	2.17E-02	1.86E-03	3.00E-01	--	7.24E-02	--	6.09%	0.00%
TOTAL													1.19E+00	9.36E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 10

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	2.12E+01	2	28	30	1E−06	70	10950	25550	4.65E−08	1.99E−08	3.00E−04	1.75E+00	1.55E−04	3.48E−08	15.21%	86.91%
Beryllium	1.30E+00	2	28	30	1E−06	70	10950	25550	2.85E−09	1.22E−09	5.00E−03	4.30E+00	5.70E−07	5.25E−09	0.06%	13.09%
Iron	1.08E+05	2	28	30	1E−06	70	10950	25550	2.37E−04	1.01E−04	3.00E−01	--	7.89E−04	--	77.51%	0.00%
Nickel	1.05E+02	2	28	30	1E−06	70	10950	25550	2.30E−07	9.86E−08	2.00E−02	--	1.15E−05	--	1.13%	0.00%
Zinc	8.49E+03	2	28	30	1E−06	70	10950	25550	1.86E−05	7.97E−06	3.00E−01	--	6.20E−05	--	6.09%	0.00%
TOTAL													1.02E−03	4.01E−08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 10

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	2.12E+01	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	3.95E-07	3.38E-08	3.00E-04	1.75E+00	1.32E-03	5.92E-08	15.59%	86.91%
Beryllium	1.30E+00	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	2.42E-08	2.07E-09	5.00E-03	4.30E+00	4.84E-06	8.92E-09	0.06%	13.09%
Iron	1.08E+05	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	2.01E-03	1.72E-04	3.00E-01	--	6.70E-03	-	79.44%	0.00%
Nickel	1.05E+02	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	1.95E-06	1.68E-07	2.00E-02	--	9.77E-05	-	1.16%	0.00%
Zinc	8.49E+03	7280	0.0006 *	0.2	14	6	1E-06	15	2190	25550	9.48E-05	8.13E-06	3.00E-01	--	3.16E-04	-	3.75%	0.00%
TOTAL															8.44E-03	6.81E-08	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 10

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Arsenic	2.12E+01	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	5.34E-07	2.29E-07	3.00E-04	1.75E+00	1.76E-03	4.01E-07	15.59%	86.91%
Beryllium	1.30E+00	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	3.28E-08	1.40E-08	5.00E-03	4.30E+00	6.55E-06	6.04E-08	0.06%	13.09%
Iron	1.08E+05	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	2.72E-03	1.17E-03	3.00E-01	--	9.07E-03	–	79.44%	0.00%
Nickel	1.05E+02	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	2.65E-06	1.13E-06	2.00E-02	--	1.32E-04	–	1.16%	0.00%
Zinc	8.49E+03	23000	0.0006 *	0.2	28	30	1E-06	70	10950	25550	1.28E-04	5.50E-05	3.00E-01	--	4.28E-04	–	3.75%	0.00%
TOTAL															1.14E-02	4.61E-07	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 10
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)			Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
TOTAL DISSOLVE METALS									
INORGANICS									
Aluminum	1 / 5		147 b			11000			NO
Arsenic	3 / 5	3.8 b	–	16.2	0.018	0.038	50	50	YES
Barium [e]	5 / 5	3.6 b	–	132 b		260	2000	1000	NO
Cadmium	1 / 5		4.4 b			18	5	0.4	NO
Calcium	5 / 5	25700	–	74400					NO
Cobalt [e]	1 / 5		22.3 b			220			NO
Iron	5 / 5	28 b	–	9180					YES
Magnesium	5 / 5	3220 j	–	7780					NO
Manganese	5 / 5	13.3 b	–	854		18			NO
Nickel	1 / 5		92.6		610	73	100		YES
Potassium	5 / 5	2140 b	–	5540					NO
Sodium	5 / 5	5100 b	–	18200				270000	NO
Zinc	2 / 5	75	–	8170		1100		50	YES

Notes:

a. Federal MCL concentration values represent US Federal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the Januray 7, 1994 RBC Table using a target hazard quotient of 0.1.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

e. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 10

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
TOTAL DISSOLVE METALS																
Arsenic	1.62E+01	1	14	6	1E-03	15	2190	25550	4.14E-05	3.55E-06	3.00E-04	1.75E+00	1.38E-01	6.21E-06	46.37%	100.00%
Iron	9.18E+03	1	14	6	1E-03	15	2190	25550	2.35E-02	2.01E-03	3.00E-01	--	7.82E-02	--	26.27%	0.00%
Nickel	9.26E+01	1	14	6	1E-03	15	2190	25550	2.37E-04	2.03E-05	2.00E-02	--	1.18E-02	--	3.98%	0.00%
Zinc	8.17E+03	1	14	6	1E-03	15	2190	25550	2.09E-02	1.79E-03	3.00E-01	--	6.96E-02	--	23.38%	0.00%
TOTAL													2.98E-01	6.21E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 10

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
TOTAL DISSOLVE METALS																
Arsenic	1.62E+01	2	28	30	1E−06	70	10950	25550	3.55E−08	1.52E−08	3.00E−04	1.75E+00	1.18E−04	2.66E−08	46.37%	100.00%
Iron	9.18E+03	2	28	30	1E−06	70	10950	25550	2.01E−05	8.62E−06	3.00E−01	--	6.71E−05	--	26.27%	0.00%
Nickel	9.26E+01	2	28	30	1E−06	70	10950	25550	2.03E−07	8.70E−08	2.00E−02	--	1.01E−05	--	3.98%	0.00%
Zinc	8.17E+03	2	28	30	1E−06	70	10950	25550	1.79E−05	7.67E−06	3.00E−01	--	5.97E−05	--	23.38%	0.00%
TOTAL													2.55E−04	2.66E−08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 10

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
TOTAL DISSOLVE METALS																		
Arsenic	1.62E+01	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	3.02E-07	2.58E-08	3.00E-04	1.75E+00	1.01E-03	4.52E-08	51.15%	100.00%
Iron	9.18E+03	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	1.71E-04	1.46E-05	3.00E-01	--	5.70E-04	–	28.99%	0.00%
Nickel	9.26E+01	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	1.72E-06	1.48E-07	2.00E-02	--	8.62E-05	–	4.39%	0.00%
Zinc	8.17E+03	7280	0.0006 *	0.2	14	6	1E-06	15	2190	25550	9.13E-05	7.82E-06	3.00E-01	--	3.04E-04	–	15.48%	0.00%
TOTAL															1.97E-03	4.52E-08	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 10

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
TOTAL DISSOLVE METALS																		
Arsenic	1.62E+01	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	4.08E-07	1.75E-07	3.00E-04	1.75E+00	1.36E-03	3.06E-07	51.15%	100.00%
Iron	9.18E+03	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	2.31E-04	9.92E-05	3.00E-01	--	7.71E-04	–	28.99%	0.00%
Nickel	9.26E+01	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	2.33E-06	1.00E-06	2.00E-02	--	1.17E-04	–	4.39%	0.00%
Zinc	8.17E+03	23000	0.0006 *	0.2	28	30	1E-06	70	10950	25550	1.24E-04	5.30E-05	3.00E-01	--	4.12E-04	–	15.48%	0.00%
TOTAL															2.66E-03	3.06E-07	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

IEUBK MODEL OPTIONS
SITE - 10

Parameter	Default Option	User Defined Option
Air		
Outdoor air lead concentration ($\mu g/m^3$)	0.10	0.00
Ratio of indoor to outdoor air lead concentration (%)	30	00
Time outdoors (hours/day)		
Age =		
0-1 year (0-11 mo)	1	1
1-2 years (12-23 mo)	2	2
2-3 years (24-35 mo)	3	3
3-7 years (36-83 mo)	4	4
Ventilation rate (m^2/day)		
Age =		
0-1 year (0-11 mo)	2	2
1-2 years (12-23 mo)	3	3
2-3 years (24-35 mo)	5	5
3-4 years (36-47 mo)	5	5
4-5 years (48-59 mo)	5	5
5-6 years (60-71 mo)	7	7
6-7 years (72-84 mo)	7	7
Lung absorption (%)	32	00
Dietary lead intake ($\mu g/m^3$)		
Age =		
0-1 year (0-11 mo)	5.53	0.00
1-2 years (12-23 mo)	5.78	0.00
2-3 years (24-35 mo)	6.49	0.00
3-4 years (36-47 mo)	6.24	0.00
4-5 years (48-59 mo)	6.01	0.00
5-6 years (60-71 mo)	6.34	0.00
6-7 years (72-84 mo)	7.00	0.00
Alternate Diet Sources		
Concentration (μg Pb/g)		
home-grown fruits	0	0.000
home-grown vegetables	0	0.000
fish from fishing	0	0.000
game from hunting	0	0.000
Percent of food class (%)		
home-grown fruits	0	0
home-grown vegetables	0	0
fish from fishing	0	0
game from hunting	0	0

IEUBK MODEL OPTIONS

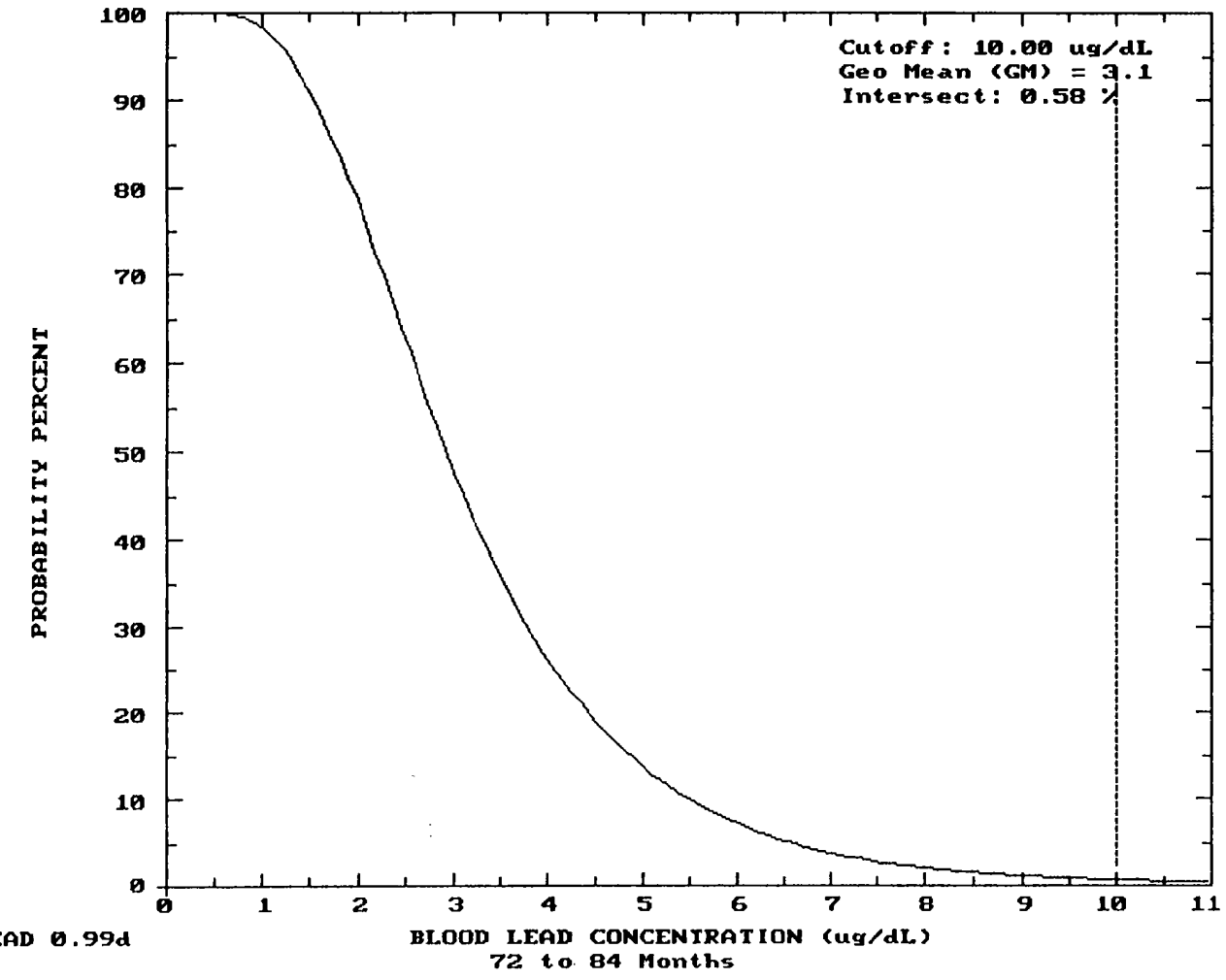
SITE - 10 (Continued)

Parameter	Default Option	User Defined Option
Drinking Water		
Lead concentration in drinking water (μg/L)	4	7.7
Ingestion rate (liters/day)		
Age =		
0-1 year (0-11 mo)	0.20	2
1-2 years (12-23 mo)	0.50	2
2-3 years (24-35 mo)	0.52	2
3-4 years (36-47 mo)	0.53	2
4-5 years (48-59 mo)	0.55	2
5-6 years (60-71 mo)	0.58	2
6-7 years (72-84 mo)	0.59	2
Soil/Dust		
Concentration		
Soil	200	9.8
Dust	200	9.8
Soil ingestion as percent of total soil and dust ingestion	45	45
Soil/Dust lead concentration (μg/g)		
Age =		
0-1 year (0-11 mo)	0.085	0.085
1-2 years (12-23 mo)	0.135	0.135
2-3 years (24-35 mo)	0.135	0.135
3-4 years (36-47 mo)	0.135	0.135
4-5 years (48-59 mo)	0.100	0.100
5-6 years (60-71 mo)	0.090	0.090
6-7 years (72-84 mo)	0.085	0.085
Dust lead concentration (μg/g)		
Age =	0.0	0.0
1-2 years (12-23 mo)	0.0	0.0
2-3 years (24-35 mo)	0.0	0.0
3-4 years (36-47 mo)	0.0	0.0
4-5 years (48-59 mo)	0.0	0.0
5-6 years (60-71 mo)	0.0	0.0
6-7 years (72-84 mo)	0.0	0.0

IEUBK MODEL OPTIONS

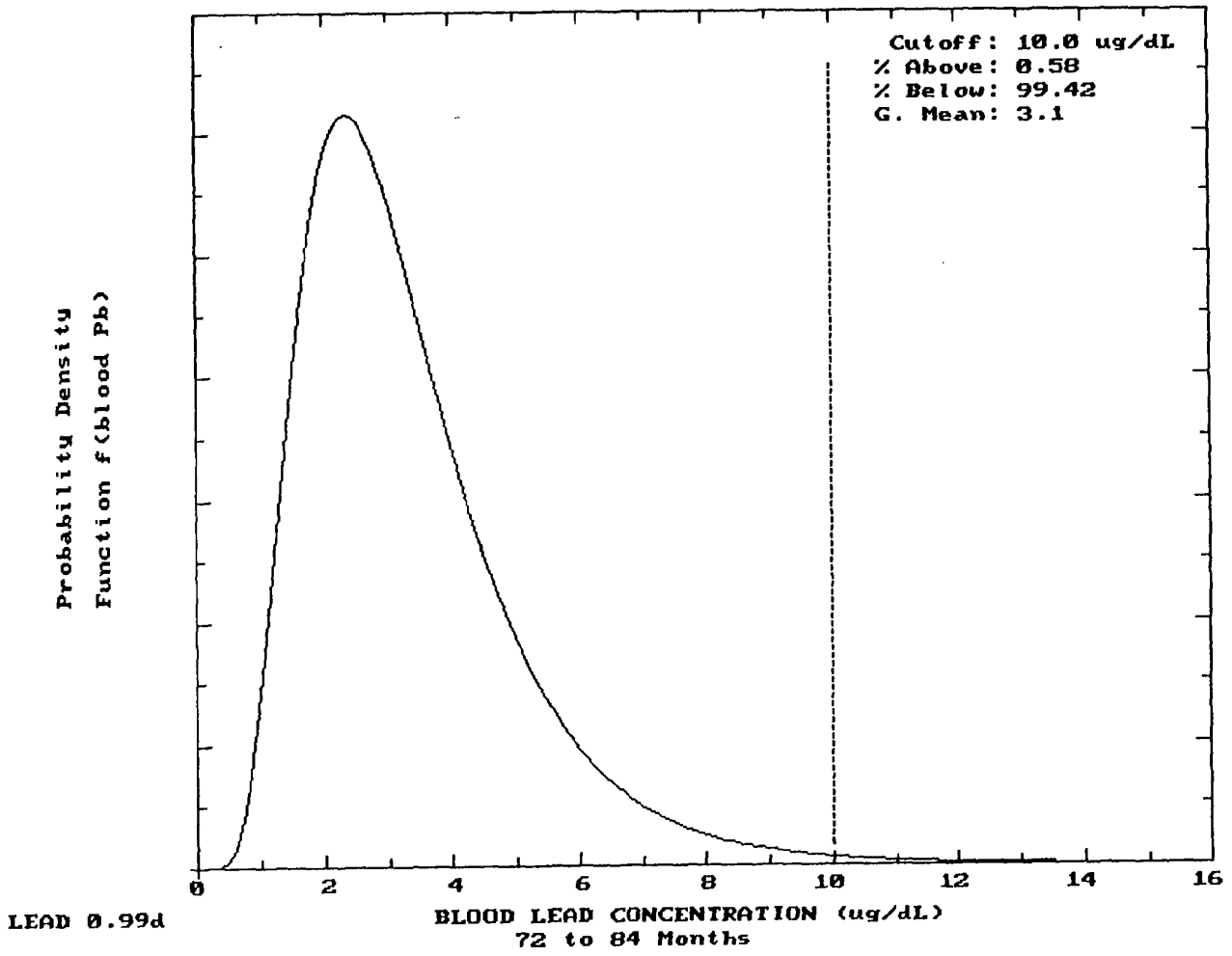
SITE - 10 (Continued)

Parameter	Default Option	User Defined Option
Bioavailability For All Gut Absorption Pathways		
Total lead Absorption (at low intake)		
diet	50	50
drinking water	50	50
soil	30	30
dust	30	30
alternate source	0	0
Fraction of lead absorbed at high intake		
diet	0.2	0.2
drinking water	0.2	0.2
soil	0.2	0.2
dust	0.2	0.2
alternate source	0.2	0.2
Maternal-to-Newborn Lead Exposure		
Mother's blood lead level at time of birth	2.5	2.5
Geometric standard deviation for blood lead (GSD)	1.6	1.6
Blood lead level of concern	10	10



LEAD 0.99d

Site 10



Site 10
Figure N-6

SITE - 11

CONSTITUENTS DETECTED IN SURFACE SOIL SAMPLES
SITE 11
NAVAL AMPHIBIOUS BASES – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)	Residential Soil Concentration (ug/kg) [a]	Potential Concern
VOLATILES				
Acetone	8 / 10	8 j – 36	7.80E+05	NO
Toluene	1 / 10	3 j	1.60E+06	NO

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

CONSTITUENTS DETECTED IN SURFACE SOIL SAMPLES
SITE 11
NAVAL AMPHIBIOUS BASES – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Residential Soil Concentration (mg/kg) [a]	Potential Concern
INORGANICS				
Aluminum	5 / 5	6360 – 12400	2.30E+04	NO
Antimony [b]	1 / 5	11 b	3.10E+00	YES
Arsenic	5 / 5	2.3 – 9	3.70E−01	YES
Barium	5 / 5	31.7 b – 74.4	5.50E+02	NO
Beryllium [b]	5 / 5	0.21 b – 0.53 b	1.50E−01	YES
Cadmium	3 / 5	2.2 – 3.4	3.90E+01	NO
Calcium	5 / 5	527 – 1710		NO
Chromium	5 / 5	13 – 125	3.90E+01	YES
Cobalt [b]	5 / 5	1.5 b – 7.4 b	4.70E+02	NO
Copper	5 / 5	5.7 – 227	2.90E+02	NO
Iron	5 / 5	3270 – 74900		YES
Lead	5 / 5	15.7 – 526		YES *
Magnesium	5 / 5	468 – 1110 j		NO
Manganese	5 / 5	21.2 – 522	3.90E+01	YES
Mercury	2 / 5	0.81 j – 2.5	2.30E+00	YES
Nickel	5 / 5	4.7 b – 23.2	1.60E+02	NO
Potassium	5 / 5	255 – 596		NO
Selenium	2 / 5	1.3 – 2.1	3.90E+01	NO
Silver	1 / 5	22.7	3.90E+01	NO
Thallium [b]	1 / 5	1.5 b		YES
Vanadium	5 / 5	13.2 – 26.4	5.50E+01	NO
Zinc	5 / 5	18.9 – 670	2.30E+03	NO

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum where it is obtained from the January 11, 1994 RBC Table using a target hazard quotient of 0.1 and a target cancer risk of 1e−06.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

b. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 11

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	200	1	14	6	1E-06	15	2190	25550	5.63E-06	4.82E-07	4.00E-04	--	1.41E-02	--	6.18%	0.00%
Arsenic	9.00E+00	200	1	14	6	1E-06	15	2190	25550	4.60E-06	3.95E-07	3.00E-04	1.75E+00	1.53E-02	6.90E-07	6.74%	87.36%
Beryllium	5.30E-01	200	1	14	6	1E-06	15	2190	25550	2.71E-07	2.32E-08	5.00E-03	4.30E+00	5.42E-05	9.99E-08	0.02%	12.64%
Chromium	1.25E+02	200	1	14	6	1E-06	15	2190	25550	6.39E-05	5.48E-06	5.00E-03	--	1.28E-02	--	5.62%	0.00%
Iron	7.49E+04	200	1	14	6	1E-06	15	2190	25550	3.83E-02	3.28E-03	3.00E-01	--	1.28E-01	--	56.10%	0.00%
Manganese	5.22E+02	200	1	14	6	1E-06	15	2190	25550	2.67E-04	2.29E-05	5.00E-03	--	5.34E-02	--	23.46%	0.00%
Mercury	2.50E+00	200	1	14	6	1E-06	15	2190	25550	1.28E-06	1.10E-07	3.00E-04	--	4.26E-03	--	1.87%	0.00%
Thallium	1.50E+00	200	1	14	6	1E-06	15	2190	25550	7.67E-07	6.58E-08	--	--	--	--	0.00%	0.00%
TOTAL														2.28E-01	7.90E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 11

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	100	1	28	30	1E-06	70	10950	25550	1.21E-06	5.17E-07	4.00E-04	--	3.01E-03	--	6.18%	0.00%
Arsenic	9.00E+00	100	1	28	30	1E-06	70	10950	25550	9.86E-07	4.23E-07	3.00E-04	1.75E+00	3.29E-03	7.40E-07	6.74%	87.36%
Beryllium	5.30E-01	100	1	28	30	1E-06	70	10950	25550	5.81E-08	2.49E-08	5.00E-03	4.30E+00	1.16E-05	1.07E-07	0.02%	12.64%
Chromium	1.25E+02	100	1	28	30	1E-06	70	10950	25550	1.37E-05	5.87E-06	5.00E-03	--	2.74E-03	--	5.62%	0.00%
Iron	7.49E+04	100	1	28	30	1E-06	70	10950	25550	8.21E-03	3.52E-03	3.00E-01	--	2.74E-02	--	56.10%	0.00%
Manganese	5.22E+02	100	1	28	30	1E-06	70	10950	25550	5.72E-05	2.45E-05	5.00E-03	--	1.14E-02	--	23.46%	0.00%
Mercury	2.50E+00	100	1	28	30	1E-06	70	10950	25550	2.74E-07	1.17E-07	3.00E-04	--	9.13E-04	--	1.87%	0.00%
Thallium	1.50E+00	100	1	28	30	1E-06	70	10950	25550	1.64E-07	7.05E-08	--	--	--	--	0.00%	0.00%
TOTAL														4.88E-02	8.47E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 11

CURRENT SCENARIO
SOIL – INGESTION
WORKER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	50	1	250	25	1E−06	70	9125	25550	5.38E−06	1.92E−06	4.00E−04	--	1.35E−02	--	6.18%	0.00%
Arsenic	9.00E+00	50	1	250	25	1E−06	70	9125	25550	4.40E−06	1.57E−06	3.00E−04	1.75E+00	1.47E−02	2.75E−06	6.74%	87.36%
Beryllium	5.30E−01	50	1	250	25	1E−06	70	9125	25550	2.59E−07	9.26E−08	5.00E−03	4.30E+00	5.19E−05	3.98E−07	0.02%	12.64%
Chromium	1.25E+02	50	1	250	25	1E−06	70	9125	25550	6.12E−05	2.18E−05	5.00E−03	--	1.22E−02	--	5.62%	0.00%
Iron	7.49E+04	50	1	250	25	1E−06	70	9125	25550	3.66E−02	1.31E−02	3.00E−01	--	1.22E−01		56.10%	0.00%
Manganese	5.22E+02	50	1	250	25	1E−06	70	9125	25550	2.55E−04	9.12E−05	5.00E−03	--	5.11E−02	--	23.46%	0.00%
Mercury	2.50E+00	50	1	250	25	1E−06	70	9125	25550	1.22E−06	4.37E−07	3.00E−04	--	4.08E−03	--	1.87%	0.00%
Thallium	1.50E+00	50	1	250	25	1E−06	70	9125	25550	7.34E−07	2.62E−07	--	--	--	--	0.00%	0.00%
TOTAL														2.18E−01	3.15E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 11

CURRENT SCENARIO
SOIL – DERMAL
TRESPASSER CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	5.12E-08	4.39E-09	4.00E-04	--	1.28E-04	–	6.18%	0.00%
Arsenic	9.00E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	4.19E-08	3.59E-09	3.00E-04	1.75E+00	1.40E-04	6.28E-09	6.74%	87.36%
Beryllium	5.30E-01	1820	1	0.001	14	6	1E-06	15	2190	25550	2.47E-09	2.11E-10	5.00E-03	4.30E+00	4.93E-07	9.09E-10	0.02%	12.64%
Chromium	1.25E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	5.82E-07	4.99E-08	5.00E-03	--	1.16E-04	–	5.62%	0.00%
Iron	7.49E+04	1820	1	0.001	14	6	1E-06	15	2190	25550	3.49E-04	2.99E-05	3.00E-01	--	1.16E-03	–	56.10%	0.00%
Manganese	5.22E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	2.43E-06	2.08E-07	5.00E-03	--	4.86E-04	–	23.46%	0.00%
Mercury	2.50E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	1.16E-08	9.97E-10	3.00E-04	--	3.88E-05	–	1.87%	0.00%
Thallium	1.50E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	6.98E-09	5.98E-10	--	--	--	–	0.00%	0.00%
TOTAL															2.07E-03	7.19E-09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 11

CURRENT SCENARIO
SOIL – DERMAL
TRESPASSER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	6.99E-08	3.00E-08	4.00E-04	--	1.75E-04	–	6.18%	0.00%
Arsenic	9.00E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	5.72E-08	2.45E-08	3.00E-04	1.75E+00	1.91E-04	4.29E-08	6.74%	87.36%
Beryllium	5.30E-01	5800	1	0.001	28	30	1E-06	70	10950	25550	3.37E-09	1.44E-09	5.00E-03	4.30E+00	6.74E-07	6.21E-09	0.02%	12.64%
Chromium	1.25E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	7.95E-07	3.41E-07	5.00E-03	--	1.59E-04	–	5.62%	0.00%
Iron	7.49E+04	5800	1	0.001	28	30	1E-06	70	10950	25550	4.76E-04	2.04E-04	3.00E-01	--	1.59E-03	–	56.10%	0.00%
Manganese	5.22E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	3.32E-06	1.42E-06	5.00E-03	--	6.64E-04	–	23.46%	0.00%
Mercury	2.50E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	1.59E-08	6.81E-09	3.00E-04	--	5.30E-05	–	1.87%	0.00%
Thallium	1.50E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	9.53E-09	4.09E-09	--	--	--	–	0.00%	0.00%
TOTAL															2.83E-03	4.91E-08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 11

CURRENT SCENARIO
SOIL – DERMAL
WORKER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	6.24E-07	2.23E-07	4.00E-04	--	1.56E-03	--	6.18%	0.00%
Arsenic	9.00E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	5.11E-07	1.82E-07	3.00E-04	1.75E+00	1.70E-03	3.19E-07	6.74%	87.36%
Beryllium	5.30E-01	5800	1	0.001	250	25	1E-06	70	9125	25550	3.01E-08	1.07E-08	5.00E-03	4.30E+00	6.02E-06	4.62E-08	0.02%	12.64%
Chromium	1.25E+02	5800	1	0.001	250	25	1E-06	70	9125	25550	7.09E-06	2.53E-06	5.00E-03	--	1.42E-03	--	5.62%	0.00%
Iron	7.49E+04	5800	1	0.001	250	25	1E-06	70	9125	25550	4.25E-03	1.52E-03	3.00E-01	--	1.42E-02	--	56.10%	0.00%
Manganese	5.22E+02	5800	1	0.001	250	25	1E-06	70	9125	25550	2.96E-05	1.06E-05	5.00E-03	--	5.92E-03	--	23.46%	0.00%
Mercury	2.50E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	1.42E-07	5.07E-08	3.00E-04	--	4.73E-04	--	1.87%	0.00%
Thallium	1.50E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	8.51E-08	3.04E-08	--	--	--	--	0.00%	0.00%
TOTAL															2.53E-02	3.65E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 11

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	200	1	350	6	1E−06	15	2190	25550	1.41E−04	1.21E−05	4.00E−04	--	3.52E−01	--	6.18%	0.00%
Arsenic	9.00E+00	200	1	350	6	1E−06	15	2190	25550	1.15E−04	9.86E−06	3.00E−04	1.75E+00	3.84E−01	1.73E−05	6.74%	87.36%
Beryllium	5.30E−01	200	1	350	6	1E−06	15	2190	25550	6.78E−06	5.81E−07	5.00E−03	4.30E+00	1.36E−03	2.50E−06	0.02%	12.64%
Chromium	1.25E+02	200	1	350	6	1E−06	15	2190	25550	1.60E−03	1.37E−04	5.00E−03	--	3.20E−01	--	5.62%	0.00%
Iron	7.49E+04	200	1	350	6	1E−06	15	2190	25550	9.58E−01	8.21E−02	3.00E−01	--	3.19E+00	--	56.10%	0.00%
Manganese	5.22E+02	200	1	350	6	1E−06	15	2190	25550	6.67E−03	5.72E−04	5.00E−03	--	1.33E+00	--	23.46%	0.00%
Mercury	2.50E+00	200	1	350	6	1E−06	15	2190	25550	3.20E−05	2.74E−06	3.00E−04	--	1.07E−01	--	1.87%	0.00%
Thallium	1.50E+00	200	1	350	6	1E−06	15	2190	25550	1.92E−05	1.64E−06	--	--	--	--	0.00%	0.00%
TOTAL														5.69E+00	1.98E−05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 11

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	100	1	350	30	1E−06	70	10950	25550	1.51E−05	6.46E−06	4.00E−04	--	3.77E−02	--	6.18%	0.00%
Arsenic	9.00E+00	100	1	350	30	1E−06	70	10950	25550	1.23E−05	5.28E−06	3.00E−04	1.75E+00	4.11E−02	9.25E−06	6.74%	87.36%
Beryllium	5.30E−01	100	1	350	30	1E−06	70	10950	25550	7.26E−07	3.11E−07	5.00E−03	4.30E+00	1.45E−04	1.34E−06	0.02%	12.64%
Chromium	1.25E+02	100	1	350	30	1E−06	70	10950	25550	1.71E−04	7.34E−05	5.00E−03	--	3.42E−02	--	5.62%	0.00%
Iron	7.49E+04	100	1	350	30	1E−06	70	10950	25550	1.03E−01	4.40E−02	3.00E−01	--	3.42E−01	--	56.10%	0.00%
Manganese	5.22E+02	100	1	350	30	1E−06	70	10950	25550	7.15E−04	3.06E−04	5.00E−03	--	1.43E−01	--	23.46%	0.00%
Mercury	2.50E+00	100	1	350	30	1E−06	70	10950	25550	3.42E−06	1.47E−06	3.00E−04	--	1.14E−02	--	1.87%	0.00%
Thallium	1.50E+00	100	1	350	30	1E−06	70	10950	25550	2.05E−06	8.81E−07	--	--	--	--	0.00%	0.00%
TOTAL														6.10E−01	1.06E−05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 11

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	1820	1	0.001	350	6	1E-06	15	2190	25550	1.28E-06	1.10E-07	4.00E-04	--	3.20E-03	--	6.18%	0.00%
Arsenic	9.00E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	1.05E-06	8.98E-08	3.00E-04	1.75E+00	3.49E-03	1.57E-07	6.74%	87.36%
Beryllium	5.30E-01	1820	1	0.001	350	6	1E-06	15	2190	25550	6.17E-08	5.29E-09	5.00E-03	4.30E+00	1.23E-05	2.27E-08	0.02%	12.64%
Chromium	1.25E+02	1820	1	0.001	350	6	1E-06	15	2190	25550	1.45E-05	1.25E-06	5.00E-03	--	2.91E-03	--	5.62%	0.00%
Iron	7.49E+04	1820	1	0.001	350	6	1E-06	15	2190	25550	8.71E-03	7.47E-04	3.00E-01	--	2.90E-02	--	56.10%	0.00%
Manganese	5.22E+02	1820	1	0.001	350	6	1E-06	15	2190	25550	6.07E-05	5.21E-06	5.00E-03	--	1.21E-02	--	23.46%	0.00%
Mercury	2.50E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	2.91E-07	2.49E-08	3.00E-04	--	9.70E-04	--	1.87%	0.00%
Thallium	1.50E+00	1820	1	0.001	350	6	1E-06	15	2190	25550	1.75E-07	1.50E-08	--	--	--	--	0.00%	0.00%
TOTAL															5.18E-02	1.80E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 11

FUTURE SCENARIO
SOIL -- DERMAL
RESIDENT ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Antimony	1.10E+01	5800	1	0.001	350	30	1E-06	70	10950	25550	8.74E-07	3.75E-07	4.00E-04	--	2.18E-03	--	6.18%	0.00%
Arsenic	9.00E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	7.15E-07	3.06E-07	3.00E-04	1.75E+00	2.38E-03	5.36E-07	6.74%	87.36%
Beryllium	5.30E-01	5800	1	0.001	350	30	1E-06	70	10950	25550	4.21E-08	1.80E-08	5.00E-03	4.30E+00	8.42E-06	7.76E-08	0.02%	12.64%
Chromium	1.25E+02	5800	1	0.001	350	30	1E-06	70	10950	25550	9.93E-06	4.26E-06	5.00E-03	--	1.99E-03	--	5.62%	0.00%
Iron	7.49E+04	5800	1	0.001	350	30	1E-06	70	10950	25550	5.95E-03	2.55E-03	3.00E-01	--	1.98E-02	--	56.10%	0.00%
Manganese	5.22E+02	5800	1	0.001	350	30	1E-06	70	10950	25550	4.15E-05	1.78E-05	5.00E-03	--	8.29E-03	--	23.46%	0.00%
Mercury	2.50E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	1.99E-07	8.51E-08	3.00E-04	--	6.62E-04	--	1.87%	0.00%
Thallium	1.50E+00	5800	1	0.001	350	30	1E-06	70	10950	25550	1.19E-07	5.11E-08	--	--	--	--	0.00%	0.00%
TOTAL															3.54E-02	6.14E-07	100.00%	100.00%

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 11
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)			Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
VOLATILES									
1,1–Dichloroethene	1 / 3		15		0.057	0.044	7		YES
1,1–Dichloroethane	1 / 3		11			81			NO
1,1,1–Trichloroethane	1 / 3		120			130	200		NO
Trichloroethene	1 / 3		120		2.7	1.6	5		YES
INORGANICS									
Aluminum	3 / 3	335 j	–	5090 j		11000			NO
Barium [e]	3 / 3	25.3 b	–	46.1 b		260	2000	1000	NO
Calcium	3 / 3	5770	–	15700					NO
Chromium	1 / 3		5 j			18	100	50	YES
Cobalt [e]	2 / 3	3.4 b	–	4.7 b		220			NO
Copper [e]	2 / 3	4.3 b	–	7.2 b		140	1300	1000	NO
Iron	3 / 3	615 j	–	3870 j					YES
Lead	2 / 3	3.9 j	–	6.4 j				50	YES *
Magnesium	3 / 3	3290 j	–	4540 j					NO
Manganese	3 / 3	81.8	–	404		18			NO
Potassium	3 / 3	1480 j	–	2640 j					NO
Sodium	3 / 3	9440	–	18700				270000	NO

Notes:

a. Federal MCL concentration values represent US Federal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the Januray 7, 1994 RBC Table using a target hazard quotient of 0.1.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

e. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER -- INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,1-Dichloroethene	1.50E+01	1	14	6	1E-03	15	2190	25550	3.84E-05	3.29E-06	9.00E-03	6.00E-01	4.26E-03	1.97E-06	4.69%	87.21%
Trichloroethene	1.20E+02	1	14	6	1E-03	15	2190	25550	3.07E-04	2.63E-05	6.00E-03	1.10E-02	5.11E-02	2.89E-07	56.23%	12.79%
Chromium	5.00E+00	1	14	6	1E-03	15	2190	25550	1.28E-05	1.10E-06	5.00E-03	--	2.56E-03	--	2.81%	0.00%
Iron	3.87E+03	1	14	6	1E-03	15	2190	25550	9.90E-03	8.48E-04	3.00E-01	--	3.30E-02	--	36.27%	0.00%
TOTAL													9.09E-02	2.26E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,1−Dichloroethene	1.50E+01	2	28	30	1E−06	70	10950	25550	3.29E−08	1.41E−08	9.00E−03	6.00E−01	3.65E−06	8.45E−09	4.69%	87.21%
Trichloroethene	1.20E+02	2	28	30	1E−06	70	10950	25550	2.63E−07	1.13E−07	6.00E−03	1.10E−02	4.38E−05	1.24E−09	56.23%	12.79%
Chromium	5.00E+00	2	28	30	1E−06	70	10950	25550	1.10E−08	4.70E−09	5.00E−03	−−	2.19E−06	−−	2.81%	0.00%
Iron	3.87E+03	2	28	30	1E−06	70	10950	25550	8.48E−06	3.64E−06	3.00E−01	−−	2.83E−05	−−	36.27%	0.00%
TOTAL													7.80E−05	9.69E−09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER -- DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,1-Dichloroethene	1.50E+01	7280	0.016 *	0.2	14	6	1E-06	15	2190	25550	4.47E-06	3.83E-07	9.00E-03	6.00E-01	4.96E-04	2.30E-07	0.57%	32.17%
Trichloroethene	1.20E+02	7280	0.23 **	0.2	14	6	1E-06	15	2190	25550	5.14E-04	4.40E-05	6.00E-03	1.10E-02	8.56E-02	4.84E-07	99.13%	67.83%
Chromium	5.00E+00	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	9.31E-08	7.98E-09	5.00E-03	--	1.86E-05	-	0.02%	0.00%
Iron	3.87E+03	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	7.20E-05	6.18E-06	3.00E-01	--	2.40E-04	-	0.28%	0.00%
TOTAL															8.64E-02	7.14E-07	100.00%	100.00%

* Chemical specific dermal permeability constant-estimated value, USEPA, 1992
** Chemical specific dermal permeability constant-measured, USEPA, 1992
*** Chemical specific dermal permeability constant-default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,1-Dichloroethene	1.50E+01	23000	0.016 *	0.2	28	30	1E-06	70	10950	25550	6.05E-06	2.59E-06	9.00E-03	6.00E-01	6.72E-04	1.56E-06	0.57%	32.17%
Trichloroethene	1.20E+02	23000	0.23 **	0.2	28	30	1E-06	70	10950	25550	6.06E-04	2.60E-04	6.00E-03	1.10E-02	1.16E-01	3.28E-06	99.13%	67.83%
Chromium	5.00E+00	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	1.26E-07	5.40E-08	5.00E-03	--	2.52E-05	--	0.02%	0.00%
Iron	3.87E+03	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	9.75E-05	4.18E-05	3.00E-01	--	3.25E-04	--	0.28%	0.00%
TOTAL															1.17E-01	4.84E-06	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INHALATION OF GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER – INHALATION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/l	CF mg/ug	WV L	RV m3	IR m3/d	EF d/yr	ED yr	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfDi mg/kg/d	CSFi (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,1−Dichloroethene	1.50E+01	1.0E−03	2.0E+02	12	0.12	14	6	15	2190	25550	7.67E−05	6.58E−06	−−	1.75E−01	0.00E+00	1.15E−06	0.00%	78.48%
Trichloroethene	1.20E+02	1.0E−03	2.0E+02	12	0.12	14	6	15	2190	25550	6.14E−04	5.26E−05	−−	6.00E−03	0.00E+00	3.16E−07	0.00%	21.52%
NA	NA	1.0E−03	2.0E+02	12	0.12	14	6	15	2190	25550	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00%	0.00%
NA	NA	1.0E−03	2.0E+02	12	0.12	14	6	15	2190	25550	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00%	0.00%
TOTAL															0.00E+00	1.47E−06	0.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INHALATION OF GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER -- INHALATION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/l	CF mg/ug	WV l	RV m3	IR m3/d	EF d/yr	ED yr	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfDi mg/kg/d	CSFi (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,1-Dichloroethene	1.50E+01	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	3.29E-05	1.41E-05	--	1.75E-01	0.00E+00	2.47E-06	0.00%	78.48%
Trichloroethene	1.20E+02	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	2.63E-04	1.13E-04	--	6.00E-03	0.00E+00	6.76E-07	0.00%	21.52%
NA	NA	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00%	0.00%
NA	NA	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	0.00E+00	0.00E+00	NA	NA	0.00E+00	0.00E+00	0.00%	0.00%
TOTAL															0.00E+00	3.14E-06	0.00%	100.00%

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 11
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)	Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
DISSOLVED METALS:							
INORGANICS							
Barium [e]	2 / 3	21 b – 24.9 b		260	2000	1000	NO
Calcium	3 / 3	5600 – 15500					NO
Cobalt [e]	1 / 3	5.3 b		220			NO
Copper [e]	1 / 3	3.4 b		140	1300	1000	NO
Iron	2 / 3	251 – 2380					YES
Magnesium	3 / 3	3390 j – 4040 j					NO
Manganese	3 / 3	67.5 – 412		18			NO
Potassium	3 / 3	1270 j – 2450 j					NO
Sodium	3 / 3	9900 – 18300				270000	NO

Notes:

a. Federal MCL concentration values represent US Federal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk-Based Concentration Table except for aluminum which is obtained from the Januray 7, 1994 RBC Table using a target hazard quotient of 0.1.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

e. Constituent concentration is five times greater than the maximum detected in blank (b).

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
DISSOLVED METALS:																
Iron	2.38E+03	1	14	6	1E−03	15	2190	25550	6.09E−03	5.22E−04	3.00E−01	--	2.03E−02	--	100.00%	0.00%
TOTAL													2.03E−02	0.00E+00	100.00%	0.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER -- INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
DISSOLVED METALS:																
Iron	2.38E+03	2	28	30	1E−06	70	10950	25550	5.22E−06	2.24E−06	3.00E−01	--	1.74E−05	--	100.00%	0.00%
TOTAL													1.74E−05	0.00E+00	100.00%	0.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
DISSOLVED METALS:																		
Iron	2.38E+03	7280	0.001 ***	0.2	14	6	1E-06	15	2190	25550	4.43E-05	3.80E-06	3.00E-01	--	1.48E-04	–	100.00%	0.00%
TOTAL															1.48E-04	0.00E+00	100.00%	0.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 11

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
DISSOLVED METALS:																		
Iron	2.38E+03	23000	0.001 ***	0.2	28	30	1E-06	70	10950	25550	6.00E-05	2.57E-05	3.00E-01	--	2.00E-04	–	100.00%	0.00%
TOTAL															2.00E-04	0.00E+00	100.00%	0.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

IEUBK MODEL OPTIONS
SITE - 11

Parameter	Default Option	User Defined Option
Air		
Outdoor air lead concentration ($\mu g/m^3$)	0.10	0.00
Ratio of indoor to outdoor air lead concentration (%)	30	00
Time outdoors (hours/day)		
Age =		
0-1 year (0-11 mo)	1	1
1-2 years (12-23 mo)	2	2
2-3 years (24-35 mo)	3	3
3-7 years (36-83 mo)	4	4
Ventilation rate (m^2/day)		
Age =		
0-1 year (0-11 mo)	2	2
1-2 years (12-23 mo)	3	3
2-3 years (24-35 mo)	5	5
3-4 years (36-47 mo)	5	5
4-5 years (48-59 mo)	5	5
5-6 years (60-71 mo)	7	7
6-7 years (72-84 mo)	7	7
Lung absorption (%)	32	00
Dietary lead intake ($\mu g/m^3$)		
Age =		
0-1 year (0-11 mo)	5.53	0.00
1-2 years (12-23 mo)	5.78	0.00
2-3 years (24-35 mo)	6.49	0.00
3-4 years (36-47 mo)	6.24	0.00
4-5 years (48-59 mo)	6.01	0.00
5-6 years (60-71 mo)	6.34	0.00
6-7 years (72-84 mo)	7.00	0.00
Alternate Diet Sources		
Concentration (μg Pb/g)		
home-grown fruits	0	0.000
home-grown vegetables	0	0.000
fish from fishing	0	0.000
game from hunting	0	0.000
Percent of food class (%)		
home-grown fruits	0	0
home-grown vegetables	0	0
fish from fishing	0	0
game from hunting	0	0

IEUBK MODEL OPTIONS

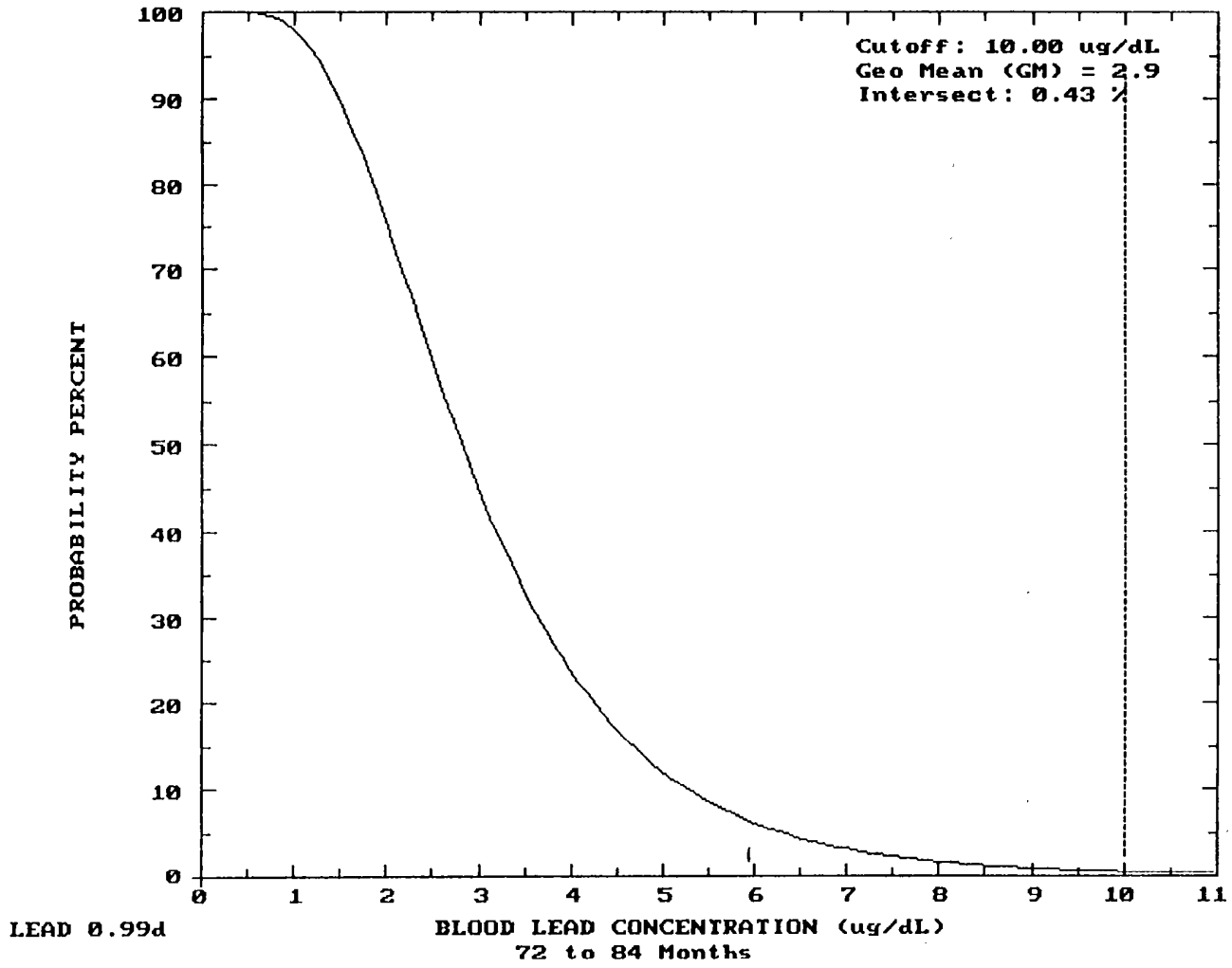
SITE - 11 (Continued)

Parameter	Default Option	User Defined Option
Drinking Water		
Lead concentration in drinking water (μg/L)	4	5.15
Ingestion rate (liters/day)		
Age =		
0-1 year (0-11 mo)	0.20	2
1-2 years (12-23 mo)	0.50	2
2-3 years (24-35 mo)	0.52	2
3-4 years (36-47 mo)	0.53	2
4-5 years (48-59 mo)	0.55	2
5-6 years (60-71 mo)	0.58	2
6-7 years (72-84 mo)	0.59	2
Soil/Dust		
Concentration		
Soil	200	227.4
Dust	200	227.4
Soil ingestion as percent of total soil and dust ingestion	45	45
Soil/Dust lead concentration (μg/g)		
Age =		
0-1 year (0-11 mo)	0.085	0.085
1-2 years (12-23 mo)	0.135	0.135
2-3 years (24-35 mo)	0.135	0.135
3-4 years (36-47 mo)	0.135	0.135
4-5 years (48-59 mo)	0.100	0.100
5-6 years (60-71 mo)	0.090	0.090
6-7 years (72-84 mo)	0.085	0.085
Dust lead concentration (μg/g)		
Age =	0.0	0.0
1-2 years (12-23 mo)	0.0	0.0
2-3 years (24-35 mo)	0.0	0.0
3-4 years (36-47 mo)	0.0	0.0
4-5 years (48-59 mo)	0.0	0.0
5-6 years (60-71 mo)	0.0	0.0
6-7 years (72-84 mo)	0.0	0.0

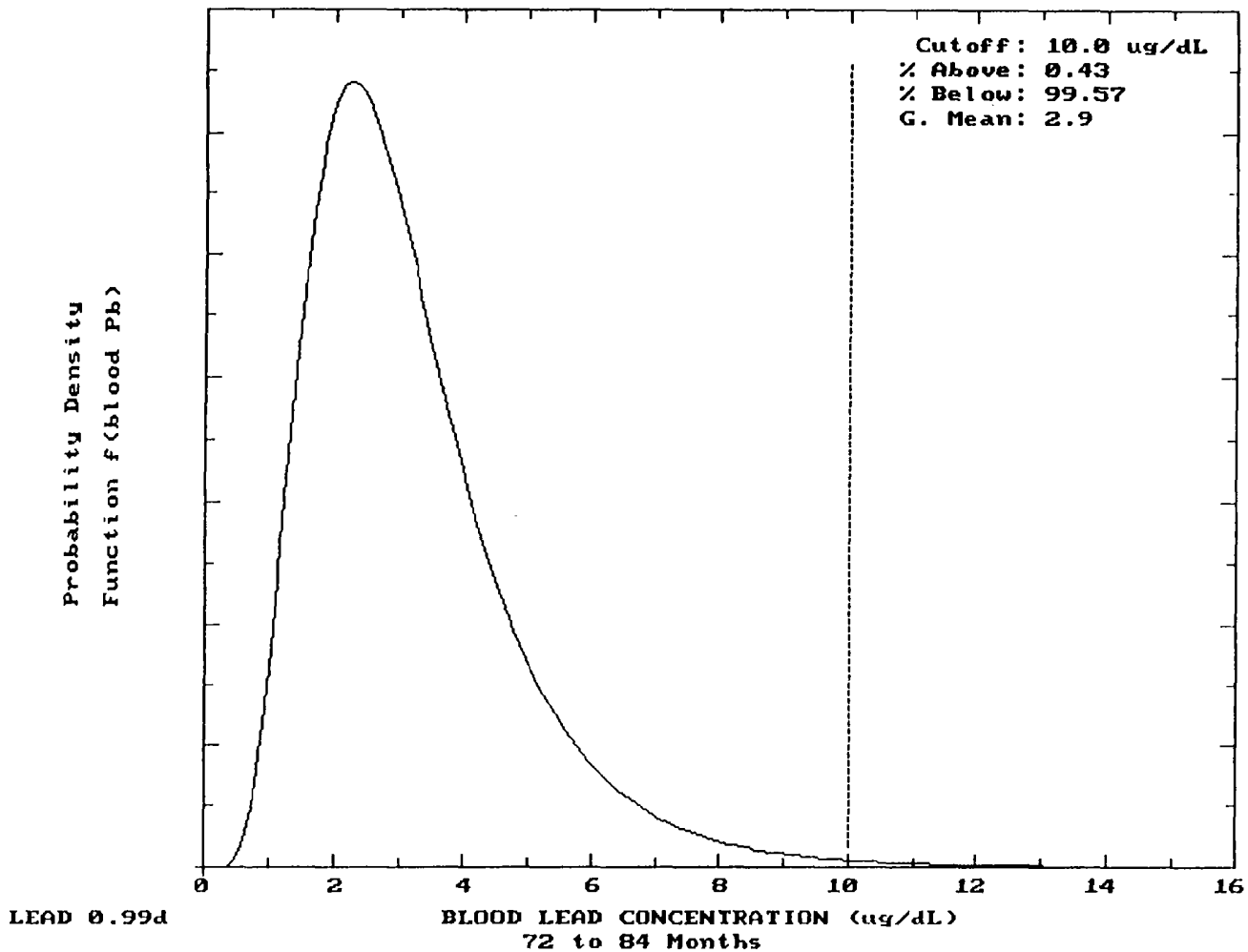
IEUBK MODEL OPTIONS

SITE - 11 (Continued)

Parameter	Default Option	User Defined Option
Bioavailability For All Gut Absorption Pathways		
Total lead Absorption (at low intake)		
diet	50	50
drinking water	50	50
soil	30	30
dust	30	30
alternate source	0	0
Fraction of lead absorbed at high intake		
diet	0.2	0.2
drinking water	0.2	0.2
soil	0.2	0.2
dust	0.2	0.2
alternate source	0.2	0.2
Maternal-to-Newborn Lead Exposure		
Mother's blood lead level at time of birth	2.5	2.5
Geometric standard deviation for blood lead (GSD)	1.6	1.6
Blood lead level of concern	10	10



Site 11
Figure N-7



Site 11
Figure N-8

SITE - 12

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 12
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)	Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
VOLATILES							
1,2–Dichloroethene (total)	2 / 4	2 j – 11000		5.5	70		YES
Chloroform	1 / 4	1 j	5.7	0.15	100		YES
Trichloroethene	3 / 4	2 j – 2300	5	1.6	300		YES
Tetrachloroethene	3 / 4	2 j – 4900	0.8	1.1	5		YES

Notes:

a. Federal MCL concentration values represent USFederal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 12

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/l	CR l/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+04	1	14	6	1E-03	15	2190	25550	2.81E-02	2.41E-03	9.00E-03	--	3.13E+00	--	58.32%	0.00%
Chloroform	1.00E+00	1	14	6	1E-03	15	2190	25550	2.56E-06	2.19E-07	1.00E-02	6.10E-03	2.56E-04	1.34E-09	0.00%	0.00%
Trichloroethene	2.30E+03	1	14	6	1E-03	15	2190	25550	5.88E-03	5.04E-04	6.00E-03	1.10E-02	9.80E-01	5.55E-06	18.29%	9.03%
Tetrachloroethene	4.90E+03	1	14	6	1E-03	15	2190	25550	1.25E-02	1.07E-03	1.00E-02	5.20E-02	1.25E+00	5.58E-05	23.38%	90.97%
TOTAL													5.36E+00	6.14E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 12

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+04	2	28	30	1E−06	70	10950	25550	2.41E−05	1.03E−05	9.00E−03	--	2.68E−03	--	58.32%	0.00%
Chloroform	1.00E+00	2	28	30	1E−06	70	10950	25550	2.19E−09	9.39E−10	1.00E−02	6.10E−03	2.19E−07	5.73E−12	0.00%	0.00%
Trichloroethene	2.30E+03	2	28	30	1E−06	70	10950	25550	5.04E−06	2.16E−06	6.00E−03	1.10E−02	8.40E−04	2.38E−08	18.29%	9.03%
Tetrachloroethene	4.90E+03	2	28	30	1E−06	70	10950	25550	1.07E−05	4.60E−06	1.00E−02	5.20E−02	1.07E−03	2.39E−07	23.38%	90.97%
TOTAL													4.59E−03	2.63E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 12

FUTURE SCENARIO
GROUNDWATER -- DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+04	7280	0.01 *	0.2	14	6	1E-06	15	2190	25550	2.05E-03	1.76E-04	9.00E-03	--	2.28E-01	--	4.34%	0.00%
Chloroform	1.00E+00	7280	0.13 **	0.2	14	6	1E-06	15	2190	25550	2.42E-06	2.07E-07	1.00E-02	6.10E-03	2.42E-04	1.27E-09	0.00%	0.00%
Trichloroethene	2.30E+03	7280	0.23 **	0.2	14	6	1E-06	15	2190	25550	9.85E-03	8.44E-04	6.00E-03	1.10E-02	1.64E+00	9.28E-06	31.30%	5.81%
Tetrachloroethene	4.90E+03	7280	0.37 **	0.2	14	6	1E-06	15	2190	25550	3.37E-02	2.89E-03	1.00E-02	5.20E-02	3.37E+00	1.50E-04	64.36%	94.19%
TOTAL															5.24E+00	1.60E-04	100.00%	100.00%

* Chemical specific dermal permeability constant-estimated value, USEPA, 1992
** Chemical specific dermal permeability constant-measured, USEPA, 1992
*** Chemical specific dermal permeability constant-default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 12

FUTURE SCENARIO
GROUNDWATER -- DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+04	23000	0.01 *	0.2	28	30	1E-06	70	10950	25550	2.77E-03	1.19E-03	9.00E-03	--	3.08E-01	-	4.34%	0.00%
Chloroform	1.00E+00	23000	0.13 **	0.2	28	30	1E-06	70	10950	25550	3.28E-06	1.40E-06	1.00E-02	6.10E-03	3.28E-04	8.57E-09	0.00%	0.00%
Trichloroethene	2.30E+03	23000	0.23 **	0.2	28	30	1E-06	70	10950	25550	1.33E-02	5.71E-03	6.00E-03	1.10E-02	2.22E+00	6.29E-05	31.30%	5.81%
Tetrachloroethene	4.90E+03	23000	0.37 **	0.2	28	30	1E-06	70	10950	25550	4.57E-02	1.96E-02	1.00E-02	5.20E-02	4.57E+00	1.02E-03	64.36%	94.19%
TOTAL															7.10E+00	1.08E-03	100.00%	100.00%

* Chemical specific dermal permeability constant-estimated value, USEPA, 1992
** Chemical specific dermal permeability constant-measured, USEPA, 1992
*** Chemical specific dermal permeability constant-default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INHALATION OF GROUNDWATER
SITE 12

FUTURE SCENARIO
GROUNDWATER -- INHALATION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/l	CF mg/ug	WV L	RV m3	IR m3/d	EF d/yr	ED yr	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfDi mg/kg/d	CSFi (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+04	1.0E-03	2.0E+02	12	0.12	14	6	15	2190	25550	5.63E-02	4.82E-03	--	--	0.00E+00	0.00E+00	0.00%	0.00%
Chloroform	1.00E+00	1.0E-03	2.0E+02	12	0.12	14	6	15	2190	25550	5.11E-06	4.38E-07	--	8.05E-02	0.00E+00	3.53E-08	0.00%	0.34%
Trichloroethene	2.30E+03	1.0E-03	2.0E+02	12	0.12	14	6	15	2190	25550	1.18E-02	1.01E-03	--	6.00E-03	0.00E+00	6.05E-06	0.00%	57.92%
Tetrachloroethene	4.90E+03	1.0E-03	2.0E+02	12	0.12	14	6	15	2190	25550	2.51E-02	2.15E-03	--	2.03E-03	0.00E+00	4.36E-06	0.00%	41.75%
TOTAL															0.00E+00	1.04E-05	0.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INHALATION OF GROUNDWATER
SITE 12

FUTURE SCENARIO
GROUNDWATER – INHALATION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/l	CF mg/ug	WV l	RV m3	IR m3/d	EF d/yr	ED yr	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfDi mg/kg/d	CSFi (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2−Dichloroethene	1.10E+04	1.0E−03	2.0E+02	12	0.12	28	30	70	10950	25550	2.41E−02	1.03E−02	--	--	0.00E+00	0.00E+00	0.00%	0.00%
Chloroform	1.00E+00	1.0E−03	2.0E+02	12	0.12	28	30	70	10950	25550	2.19E−06	9.39E−07	--	8.05E−02	0.00E+00	7.56E−08	0.00%	0.34%
Trichloroethene	2.30E+03	1.0E−03	2.0E+02	12	0.12	28	30	70	10950	25550	5.04E−03	2.16E−03	--	6.00E−03	0.00E+00	1.30E−05	0.00%	57.92%
Tetrachloroethene	4.90E+03	1.0E−03	2.0E+02	12	0.12	28	30	70	10950	25550	1.07E−02	4.60E−03	--	2.03E−03	0.00E+00	9.34E−06	0.00%	41.75%
TOTAL															0.00E+00	2.24E−05	0.00%	100.00%

CONSTITUENTS DETECTED IN SURFACE WATER
SITE 12
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)			Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Water Stds. (ug/l) [d]	Potential Concern
VOLATILES									
Acetone	3 / 4	20	–	50		370			NO
1,2–Dichloroethene (total)	1 / 4		11			5.5	70		YES
2–Butanone	1 / 4		36						NO
Trichloroethene	1 / 4		3 j		5	1.6	300	27	YES
Tetrachloroethene	1 / 4		3 j		0.8	1.1	5	318	YES
Toluene	3 / 4	2 j	–	58	6800	750	1000	6800	NO
INORGANICS									
Aluminum	2 / 4	4320j	–	81800 j		11000			YES
Arsenic	3 / 4	2.2 j	–	23.4 j	0.018	0.038	50	50	YES
Barium	4 / 4	25.3 j	–	669 j		260	2000	2000	YES
Beryllium	1 / 4		3.1 j			0.016	4		YES
Cadmium	1 / 4		7.5 j			18	5	16	YES
Calcium	4 / 4	15600 j	–	84500 j					NO
Chromium	1 / 4		148 j			18	100	170	YES
Cobalt	1 / 4		64 j			220			YES
Copper	4 / 4	4.7 j	–	305 j		140	1300	1300	YES
Iron	4 / 4	2900 j	–	94800 j				300	YES
Lead	4 / 4	2.0 j	–	312 j			0	15	YES *
Magnesium	4 / 4	5150 j	–	26600 j					NO
Manganese	4 / 4	507 j	–	1240 j		18		50	YES
Mercury	1 / 4		0.79 j		0.14	1.1	2	0.144	YES
Nickel	1 / 4		143 j		610	73	100	607	YES
Potassium	4 / 4	2800 j	–	21300 j					NO
Sodium	4 / 4	13300 j	–	262000 j					NO
Vanadium	2 / 4	11.8 j	–	162 j		26			YES
Zinc	4 / 4	39.1j	–	3800 j		1100		5000	YES

Notes:

a. Federal MCL concentration values represent USFederal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the January 7, 1994 RBC table.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Water Standards for public water supplies.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE WATER
SITE 12

CURRENT SCENARIO
SURFACE WATER – INGESTION
TRESPASSER CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+01	2	350	6	1E-03	15	2190	25550	1.41E-03	1.21E-04	9.00E-03	--	1.56E-01	--	0.16%	0.00%
Trichloroethene	3.00E+00	2	350	6	1E-03	15	2190	25550	3.84E-04	3.29E-05	6.00E-03	1.10E-02	6.39E-02	3.62E-07	0.06%	0.06%
Tetrachloroethene	3.00E+00	2	350	6	1E-03	15	2190	25550	3.84E-04	3.29E-05	1.00E-02	5.20E-02	3.84E-02	1.71E-06	0.04%	0.29%
Aluminum	8.18E+04	2	350	6	1E-03	15	2190	25550	1.05E+01	8.96E-01	2.90E+00	--	3.61E+00	--	3.61%	0.00%
Arsenic	2.34E+01	2	350	6	1E-03	15	2190	25550	2.99E-03	2.56E-04	3.00E-04	1.75E+00	9.97E+00	4.49E-04	9.98%	75.18%
Barium	6.69E+02	2	350	6	1E-03	15	2190	25550	8.55E-02	7.33E-03	7.00E-02		1.22E+00		1.22%	0.00%
Beryllium	3.10E+00	2	350	6	1E-03	15	2190	25550	3.96E-04	3.40E-05	5.00E-03	4.30E+00	7.93E-02	1.46E-04	0.08%	24.47%
Cadmium	7.50E+00	2	350	6	1E-03	15	2190	25550	9.59E-04	8.22E-05	5.00E-04	--	1.92E+00	--	1.92%	0.00%
Chromium	1.48E+02	2	350	6	1E-03	15	2190	25550	1.89E-02	1.62E-03	5.00E-03	--	3.78E+00	--	3.79%	0.00%
Cobalt	6.40E+01	2	350	6	1E-03	15	2190	25550	8.18E-03	7.01E-04	6.00E-02	--	1.36E-01	--	0.14%	0.00%
Copper	3.05E+02	2	350	6	1E-03	15	2190	25550	3.90E-02	3.34E-03	3.71E-02	--	1.05E+00	--	1.05%	0.00%
Iron	9.48E+04	2	350	6	1E-03	15	2190	25550	1.21E+01	1.04E+00	3.00E-01	--	4.04E+01	--	40.42%	0.00%
Manganese	1.24E+03	2	350	6	1E-03	15	2190	25550	1.59E-01	1.36E-02	5.00E-03	--	3.17E+01	--	31.72%	0.00%
Mercury	7.90E-01	2	350	6	1E-03	15	2190	25550	1.01E-04	8.66E-06	3.00E-04	--	3.37E-01	--	0.34%	0.00%
Nickel	1.43E+02	2	350	6	1E-03	15	2190	25550	1.83E-02	1.57E-03	2.00E-02	--	9.14E-01	--	0.91%	0.00%
Vanadium	1.62E+02	2	350	6	1E-03	15	2190	25550	2.07E-02	1.78E-03	7.00E-03	--	2.96E+00	--	2.96%	0.00%
Zinc	3.80E+03	2	350	6	1E-03	15	2190	25550	4.86E-01	4.16E-02	3.00E-01	--	1.62E+00	--	1.62%	0.00%
TOTAL													1.00E+02	5.97E-04	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE WATER
SITE 12

CURRENT SCENARIO
SURFACE WATER – INGESTION
TRESPASSER ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2−Dichloroethene	1.10E+01	2	350	30	1E−06	70	10950	25550	3.01E−07	1.29E−07	9.00E−03	--	3.35E−05	--	0.16%	0.00%
Trichloroethene	3.00E+00	2	350	30	1E−06	70	10950	25550	8.22E−08	3.52E−08	6.00E−03	1.10E−02	1.37E−05	3.87E−10	0.06%	0.06%
Tetrachloroethene	3.00E+00	2	350	30	1E−06	70	10950	25550	8.22E−08	3.52E−08	1.00E−02	5.20E−02	8.22E−06	1.83E−09	0.04%	0.29%
Aluminum	8.18E+04	2	350	30	1E−06	70	10950	25550	2.24E−03	9.60E−04	2.90E+00	--	7.73E−04	--	3.61%	0.00%
Arsenic	2.34E+01	2	350	30	1E−06	70	10950	25550	6.41E−07	2.75E−07	3.00E−04	1.75E+00	2.14E−03	4.81E−07	9.98%	75.18%
Barium	6.69E+02	2	350	30	1E−06	70	10950	25550	1.83E−05	7.86E−06	7.00E−02	--	2.62E−04	--	1.22%	0.00%
Beryllium	3.10E+00	2	350	30	1E−06	70	10950	25550	8.49E−08	3.64E−08	5.00E−03	4.30E+00	1.70E−05	1.57E−07	0.08%	24.47%
Cadmium	7.50E+00	2	350	30	1E−06	70	10950	25550	2.05E−07	8.81E−08	5.00E−04	--	4.11E−04	--	1.92%	0.00%
Chromium	1.48E+02	2	350	30	1E−06	70	10950	25550	4.05E−06	1.74E−06	5.00E−03	--	8.11E−04	--	3.79%	0.00%
Cobalt	6.40E+01	2	350	30	1E−06	70	10950	25550	1.75E−06	7.51E−07	6.00E−02	--	2.92E−05	--	0.14%	0.00%
Copper	3.05E+02	2	350	30	1E−06	70	10950	25550	8.36E−06	3.58E−06	3.71E−02	--	2.25E−04	--	1.05%	0.00%
Iron	9.48E+04	2	350	30	1E−06	70	10950	25550	2.60E−03	1.11E−03	3.00E−01	--	8.66E−03	--	40.42%	0.00%
Manganese	1.24E+03	2	350	30	1E−06	70	10950	25550	3.40E−05	1.46E−05	5.00E−03	--	6.79E−03	--	31.72%	0.00%
Mercury	7.90E−01	2	350	30	1E−06	70	10950	25550	2.16E−08	9.28E−09	3.00E−04	--	7.21E−05	--	0.34%	0.00%
Nickel	1.43E+02	2	350	30	1E−06	70	10950	25550	3.92E−06	1.68E−06	2.00E−02	--	1.96E−04	--	0.91%	0.00%
Vanadium	1.62E+02	2	350	30	1E−06	70	10950	25550	4.44E−06	1.90E−06	7.00E−03	--	6.34E−04	--	2.96%	0.00%
Zinc	3.80E+03	2	350	30	1E−06	70	10950	25550	1.04E−04	4.46E−05	3.00E−01	--	3.47E−04	--	1.62%	0.00%
TOTAL													2.14E−02	6.40E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE WATER
SITE 12

CURRENT SCENARIO
SURFACE WATER – INGESTION
WORKER ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2−Dichloroethene	1.10E+01	2	250	25	1E−06	70	9125	25550	2.15E−07	7.69E−08	9.00E−03	--	2.39E−05	--	0.16%	0.00%
Trichloroethene	3.00E+00	2	250	25	1E−06	70	9125	25550	5.87E−08	2.10E−08	6.00E−03	1.10E−02	9.78E−06	2.31E−10	0.06%	0.06%
Tetrachloroethene	3.00E+00	2	250	25	1E−06	70	9125	25550	5.87E−08	2.10E−08	1.00E−02	5.20E−02	5.87E−06	1.09E−09	0.04%	0.29%
Aluminum	8.18E+04	2	250	25	1E−06	70	9125	25550	1.60E−03	5.72E−04	2.90E+00	--	5.52E−04	--	3.61%	0.00%
Arsenic	2.34E+01	2	250	25	1E−06	70	9125	25550	4.58E−07	1.64E−07	3.00E−04	1.75E+00	1.53E−03	2.86E−07	9.98%	75.18%
Barium	6.69E+02	2	250	25	1E−06	70	9125	25550	1.31E−05	4.68E−06	7.00E−02	--	1.87E−04	--	1.22%	0.00%
Beryllium	3.10E+00	2	250	25	1E−06	70	9125	25550	6.07E−08	2.17E−08	5.00E−03	4.30E+00	1.21E−05	9.32E−08	0.08%	24.47%
Cadmium	7.50E+00	2	250	25	1E−06	70	9125	25550	1.47E−07	5.24E−08	5.00E−04	--	2.94E−04	--	1.92%	0.00%
Chromium	1.48E+02	2	250	25	1E−06	70	9125	25550	2.90E−06	1.03E−06	5.00E−03	--	5.79E−04	--	3.79%	0.00%
Cobalt	6.40E+01	2	250	25	1E−06	70	9125	25550	1.25E−06	4.47E−07	6.00E−02	--	2.09E−05	--	0.14%	0.00%
Copper	3.05E+02	2	250	25	1E−06	70	9125	25550	5.97E−06	2.13E−06	3.71E−02	--	1.61E−04	--	1.05%	0.00%
Iron	9.48E+04	2	250	25	1E−06	70	9125	25550	1.86E−03	6.63E−04	3.00E−01	--	6.18E−03	--	40.42%	0.00%
Manganese	1.24E+03	2	250	25	1E−06	70	9125	25550	2.43E−05	8.67E−06	5.00E−03	--	4.85E−03	--	31.72%	0.00%
Mercury	7.90E−01	2	250	25	1E−06	70	9125	25550	1.55E−08	5.52E−09	3.00E−04	--	5.15E−05	--	0.34%	0.00%
Nickel	1.43E+02	2	250	25	1E−06	70	9125	25550	2.80E−06	9.99E−07	2.00E−02	--	1.40E−04	--	0.91%	0.00%
Vanadium	1.62E+02	2	250	25	1E−06	70	9125	25550	3.17E−06	1.13E−06	7.00E−03	--	4.53E−04	--	2.96%	0.00%
Zinc	3.80E+03	2	250	25	1E−06	70	9125	25550	7.44E−05	2.66E−05	3.00E−01	--	2.48E−04	--	1.62%	0.00%
TOTAL													1.53E−02	3.81E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE WATER
SITE 12

CURRENT SCENARIO
SURFACE WATER – DERMAL
TRESPASSER CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+01	7280	0.01 *	2.6	350	6	1E-06	15	2190	25550	5.12E-05	4.39E-06	9.00E-03	--	5.69E-03	--	1.21%	0.00%
Trichloroethene	3.00E+00	7280	0.23 **	2.6	350	6	1E-06	15	2190	25550	3.21E-04	2.75E-05	6.00E-03	1.10E-02	5.35E-02	3.03E-07	11.35%	6.35%
Tetrachloroethene	3.00E+00	7280	0.37 **	2.6	350	6	1E-06	15	2190	25550	5.17E-04	4.43E-05	1.00E-02	5.20E-02	5.17E-02	2.30E-06	10.96%	48.26%
Aluminum	8.18E+04	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.81E-02	3.26E-03	2.90E+00	--	1.31E-02	--	2.78%	0.00%
Arsenic	2.34E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.09E-05	9.33E-07	3.00E-04	1.75E+00	3.63E-02	1.63E-06	7.70%	34.24%
Barium	6.69E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.11E-04	2.67E-05	7.00E-02		4.45E-03		0.94%	0.00%
Beryllium	3.10E+00	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.44E-06	1.24E-07	5.00E-03	4.30E+00	2.89E-04	5.32E-07	0.06%	11.15%
Cadmium	7.50E+00	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.49E-06	2.99E-07	5.00E-04	--	6.98E-03	--	1.48%	0.00%
Chromium	1.48E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	6.89E-05	5.90E-06	5.00E-03	--	1.38E-02	--	2.92%	0.00%
Cobalt	6.40E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	2.98E-05	2.55E-06	6.00E-02	--	4.96E-04	--	0.11%	0.00%
Copper	3.05E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.42E-04	1.22E-05	3.71E-02	--	3.83E-03	--	0.81%	0.00%
Iron	9.48E+04	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	4.41E-02	3.78E-03	3.00E-01	--	1.47E-01	--	31.19%	0.00%
Manganese	1.24E+03	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	5.77E-04	4.95E-05	5.00E-03	--	1.15E-01	--	24.48%	0.00%
Mercury	7.90E-01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.68E-07	3.15E-08	3.00E-04	--	1.23E-03	--	0.26%	0.00%
Nickel	1.43E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	6.66E-05	5.70E-06	2.00E-02	--	3.33E-03	--	0.71%	0.00%
Vanadium	1.62E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	7.54E-05	6.46E-06	7.00E-03	--	1.08E-02	--	2.28%	0.00%
Zinc	3.80E+03	7280	0.0006 *	2.6	350	6	1E-06	15	2190	25550	1.06E-03	9.10E-05	3.00E-01	--	3.54E-03	--	0.75%	0.00%
TOTAL															4.71E-01	4.77E-06	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE WATER
SITE 12

CURRENT SCENARIO
SURFACE WATER – DERMAL
TRESPASSER ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+01	23000	0.01 *	2.6	350	30	1E-06	70	10950	25550	3.47E-05	1.49E-05	9.00E-03	--	3.85E-03	-	1.21%	0.00%
Trichloroethene	3.00E+00	23000	0.23 **	2.6	350	30	1E-06	70	10950	25550	2.17E-04	9.32E-05	6.00E-03	1.10E-02	3.62E-02	1.02E-06	11.35%	6.35%
Tetrachloroethene	3.00E+00	23000	0.37 **	2.6	350	30	1E-06	70	10950	25550	3.50E-04	1.50E-04	1.00E-02	5.20E-02	3.50E-02	7.79E-06	10.96%	48.26%
Aluminum	8.18E+04	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.58E-02	1.10E-02	2.90E+00	--	8.89E-03	-	2.78%	0.00%
Arsenic	2.34E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	7.37E-06	3.16E-06	3.00E-04	1.75E+00	2.46E-02	5.53E-06	7.70%	34.24%
Barium	6.69E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.11E-04	9.03E-05	7.00E-02	--	3.01E-03	-	0.94%	0.00%
Beryllium	3.10E+00	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	9.77E-07	4.19E-07	5.00E-03	4.30E+00	1.95E-04	1.80E-06	0.06%	11.15%
Cadmium	7.50E+00	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.36E-06	1.01E-06	5.00E-04	--	4.73E-03	-	1.48%	0.00%
Chromium	1.48E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	4.66E-05	2.00E-05	5.00E-03	--	9.33E-03	-	2.92%	0.00%
Cobalt	6.40E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.02E-05	8.64E-06	6.00E-02	--	3.36E-04	-	0.11%	0.00%
Copper	3.05E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	9.61E-05	4.12E-05	3.71E-02	--	2.59E-03	-	0.81%	0.00%
Iron	9.48E+04	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.99E-02	1.28E-02	3.00E-01		9.96E-02		31.10%	0.00%
Manganese	1.24E+03	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	3.91E-04	1.67E-04	5.00E-03	--	7.81E-02	-	24.48%	0.00%
Mercury	7.90E-01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.49E-07	1.07E-07	3.00E-04	--	8.30E-04	-	0.26%	0.00%
Nickel	1.43E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	4.51E-05	1.93E-05	2.00E-02	--	2.25E-03	-	0.71%	0.00%
Vanadium	1.62E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	5.10E-05	2.19E-05	7.00E-03	--	7.29E-03	-	2.28%	0.00%
Zinc	3.80E+03	23000	0.0006 *	2.6	350	30	1E-06	70	10950	25550	7.18E-04	3.08E-04	3.00E-01	--	2.39E-03	-	0.75%	0.00%
TOTAL															3.19E-01	1.61E-05	100.00%	100.00%

* Chemical specific dermal permeability constant-estimated, USEPA, 1992
** Chemical specific dermal permeability constant-measured, USEPA, 1992
*** Chemical specific dermal permeability constant-default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE WATER
SITE 12

CURRENT SCENARIO
SURFACE WATER – DERMAL
WORKER ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+01	23000	0.01 *	0.3	250	25	1E-06	70	9125	25550	2.48E-05	8.84E-06	9.00E-03	--	2.75E-03	--	1.21%	0.00%
Trichloroethene	3.00E+00	23000	0.23 **	0.3	250	25	1E-06	70	9125	25550	1.55E-04	5.55E-05	6.00E-03	1.10E-02	2.59E-02	6.10E-07	11.35%	6.35%
Tetrachloroethene	3.00E+00	23000	0.37 **	0.3	250	25	1E-06	70	9125	25550	2.50E-04	8.92E-05	1.00E-02	5.20E-02	2.50E-02	4.64E-06	10.96%	48.26%
Aluminum	8.18E+04	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	1.84E-02	6.57E-03	2.90E+00	--	6.35E-03	--	2.78%	0.00%
Arsenic	2.34E+01	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	5.27E-06	1.88E-06	3.00E-04	1.75E+00	1.76E-02	3.29E-06	7.70%	34.24%
Barium	6.69E+02	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	1.51E-04	5.38E-05	7.00E-02	--	2.15E-03	--	0.94%	0.00%
Beryllium	3.10E+00	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	6.98E-07	2.49E-07	5.00E-03	4.30E+00	1.40E-04	1.07E-06	0.06%	11.15%
Cadmium	7.50E+00	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	1.69E-06	6.03E-07	5.00E-04	--	3.38E-03	--	1.48%	0.00%
Chromium	1.48E+02	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	3.33E-05	1.19E-05	5.00E-03	--	6.66E-03	--	2.92%	0.00%
Cobalt	6.40E+01	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	1.44E-05	5.14E-06	6.00E-02	--	2.40E-04	--	0.11%	0.00%
Copper	3.05E+02	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	6.86E-05	2.45E-05	3.71E-02	--	1.85E-03	--	0.81%	0.00%
Iron	9.48E+04	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	2.13E-02	7.62E-03	3.00E-01	--	7.11E-02	--	31.19%	0.00%
Manganese	1.24E+03	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	2.79E-04	9.97E-05	5.00E-03	--	5.58E-02	--	24.48%	0.00%
Mercury	7.90E-01	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	1.78E-07	6.35E-08	3.00E-04	--	5.93E-04	--	0.26%	0.00%
Nickel	1.43E+02	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	3.22E-05	1.15E-05	2.00E-02	--	1.61E-03	--	0.71%	0.00%
Vanadium	1.62E+02	23000	0.001 ***	0.3	250	25	1E-06	70	9125	25550	3.65E-05	1.30E-05	7.00E-03	--	5.21E-03	--	2.28%	0.00%
Zinc	3.80E+03	23000	0.0006 *	0.3	250	25	1E-06	70	9125	25550	5.13E-04	1.83E-04	3.00E-01	--	1.71E-03	--	0.75%	0.00%
TOTAL															2.28E-01	9.61E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE WATER
SITE 12

FUTURE SCENARIO
SURFACE WATER – INGESTION
RESIDENT CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2−Dichloroethene	1.10E+01	2	350	6	1E−03	15	2190	25550	1.41E−03	1.21E−04	9.00E−03	--	1.56E−01	--	0.16%	0.00%
Trichloroethene	3.00E+00	2	350	6	1E−03	15	2190	25550	3.84E−04	3.29E−05	6.00E−03	1.10E−02	6.39E−02	3.62E−07	0.06%	0.06%
Tetrachloroethene	3.00E+00	2	350	6	1E−03	15	2190	25550	3.84E−04	3.29E−05	1.00E−02	5.20E−02	3.84E−02	1.71E−06	0.04%	0.29%
Aluminum	8.18E+04	2	350	6	1E−03	15	2190	25550	1.05E+01	8.96E−01	2.90E+00	--	3.61E+00		3.61%	0.00%
Arsenic	2.34E+01	2	350	6	1E−03	15	2190	25550	2.99E−03	2.56E−04	3.00E−04	1.75E+00	9.97E+00	4.49E−04	9.98%	75.18%
Barium	6.69E+02	2	350	6	1E−03	15	2190	25550	8.55E−02	7.33E−03	7.00E−02	--	1.22E+00	--	1.22%	0.00%
Beryllium	3.10E+00	2	350	6	1E−03	15	2190	25550	3.96E−04	3.40E−05	5.00E−03	4.30E+00	7.93E−02	1.46E−04	0.08%	24.47%
Cadmium	7.50E+00	2	350	6	1E−03	15	2190	25550	9.59E−04	8.22E−05	5.00E−04	--	1.92E+00	--	1.92%	0.00%
Chromium	1.48E+02	2	350	6	1E−03	15	2190	25550	1.89E−02	1.62E−03	5.00E−03	--	3.78E+00	--	3.79%	0.00%
Cobalt	6.40E+01	2	350	6	1E−03	15	2190	25550	8.18E−03	7.01E−04	6.00E−02	--	1.36E−01	--	0.14%	0.00%
Copper	3.05E+02	2	350	6	1E−03	15	2190	25550	3.90E−02	3.34E−03	3.71E−02	--	1.05E+00	--	1.05%	0.00%
Iron	9.48E+04	2	350	6	1E−03	15	2190	25550	1.21E+01	1.04E+00	3.00E−01	--	4.04E+01	--	40.42%	0.00%
Manganese	1.24E+03	2	350	6	1E−03	15	2190	25550	1.59E−01	1.36E−02	5.00E−03	--	3.17E+01	--	31.72%	0.00%
Mercury	7.90E−01	2	350	6	1E−03	15	2190	25550	1.01E−04	8.66E−06	3.00E−04	--	3.37E−01	--	0.34%	0.00%
Nickel	1.43E+02	2	350	6	1E−03	15	2190	25550	1.83E−02	1.57E−03	2.00E−02	--	9.14E−01	--	0.91%	0.00%
Vanadium	1.62E+02	2	350	6	1E−03	15	2190	25550	2.07E−02	1.78E−03	7.00E−03	--	2.96E+00	--	2.96%	0.00%
Zinc	3.80E+03	2	350	6	1E−03	15	2190	25550	4.86E−01	4.16E−02	3.00E−01	--	1.62E+00	--	1.62%	0.00%
TOTAL													1.00E+02	5.97E−04	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE WATER
SITE 12

FUTURE SCENARIO
SURFACE WATER – INGESTION
RESIDENT ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2--Dichloroethene	1.10E+01	2	350	30	1E−06	70	10950	25550	3.01E−07	1.29E−07	9.00E−03	--	3.35E−05	--	0.16%	0.00%
Trichloroethene	3.00E+00	2	350	30	1E−06	70	10950	25550	8.22E−08	3.52E−08	6.00E−03	1.10E−02	1.37E−05	3.87E−10	0.06%	0.06%
Tetrachloroethene	3.00E+00	2	350	30	1E−06	70	10950	25550	8.22E−08	3.52E−08	1.00E−02	5.20E−02	8.22E−06	1.83E−09	0.04%	0.29%
Aluminum	8.18E+04	2	350	30	1E−06	70	10950	25550	2.24E−03	9.60E−04	2.90E+00	--	7.73E−04	--	3.61%	0.00%
Arsenic	2.34E+01	2	350	30	1E−06	70	10950	25550	6.41E−07	2.75E−07	3.00E−04	1.75E+00	2.14E−03	4.81E−07	9.98%	75.18%
Barium	6.69E+02	2	350	30	1E−06	70	10950	25550	1.83E−05	7.86E−06	7.00E−02	--	2.62E−04	--	1.22%	0.00%
Beryllium	3.10E+00	2	350	30	1E−06	70	10950	25550	8.49E−08	3.64E−08	5.00E−03	4.30E+00	1.70E−05	1.57E−07	0.08%	24.47%
Cadmium	7.50E+00	2	350	30	1E−06	70	10950	25550	2.05E−07	8.81E−08	5.00E−04	--	4.11E−04	--	1.92%	0.00%
Chromium	1.48E+02	2	350	30	1E−06	70	10950	25550	4.05E−06	1.74E−06	5.00E−03	--	8.11E−04	--	3.79%	0.00%
Cobalt	6.40E+01	2	350	30	1E−06	70	10950	25550	1.75E−06	7.51E−07	6.00E−02	--	2.92E−05	--	0.14%	0.00%
Copper	3.05E+02	2	350	30	1E−06	70	10950	25550	8.36E−06	3.58E−06	3.71E−02	--	2.25E−04	--	1.05%	0.00%
Iron	9.48E+04	2	350	30	1E−06	70	10950	25550	2.60E−03	1.11E−03	3.00E−01	--	8.66E−03	--	40.42%	0.00%
Manganese	1.24E+03	2	350	30	1E−06	70	10950	25550	3.40E−05	1.46E−05	5.00E−03	--	6.79E−03	--	31.72%	0.00%
Mercury	7.90E−01	2	350	30	1E−06	70	10950	25550	2.16E−08	9.28E−09	3.00E−04	--	7.21E−05	--	0.34%	0.00%
Nickel	1.43E+02	2	350	30	1E−06	70	10950	25550	3.92E−06	1.68E−06	2.00E−02	--	1.96E−04	--	0.91%	0.00%
Vanadium	1.62E+02	2	350	30	1E−06	70	10950	25550	4.44E−06	1.90E−06	7.00E−03	--	6.34E−04	--	2.96%	0.00%
Zinc	3.80E+03	2	350	30	1E−06	70	10950	25550	1.04E−04	4.46E−05	3.00E−01	--	3.47E−04	--	1.62%	0.00%
TOTAL													2.14E−02	6.40E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE WATER
SITE 12

FUTURE SCENARIO
SURFACE WATER – DERMAL
RESIDENT CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+01	7280	0.01 *	2.6	350	6	1E-06	15	2190	25550	5.12E-05	4.39E-06	9.00E-03	--	5.69E-03	–	1.21%	0.00%
Trichloroethene	3.00E+00	7280	0.23 **	2.6	350	6	1E-06	15	2190	25550	3.21E-04	2.75E-05	6.00E-03	1.10E-02	5.35E-02	3.03E-07	11.35%	6.35%
Tetrachloroethene	3.00E+00	7280	0.37 **	2.6	350	6	1E-06	15	2190	25550	5.17E-04	4.43E-05	1.00E-02	5.20E-02	5.17E-02	2.30E-06	10.96%	48.26%
Aluminum	8.18E+04	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.81E-02	3.26E-03	2.90E+00	--	1.31E-02	–	2.78%	0.00%
Arsenic	2.34E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.09E-05	9.33E-07	3.00E-04	1.75E+00	3.63E-02	1.63E-06	7.70%	34.24%
Barium	6.69E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.11E-04	2.67E-05	7.00E-02	--	4.45E-03	–	0.94%	0.00%
Beryllium	3.10E+00	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.44E-06	1.24E-07	5.00E-03	4.30E+00	2.89E-04	5.32E-07	0.06%	11.15%
Cadmium	7.50E+00	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.49E-06	2.99E-07	5.00E-04	--	6.98E-03	–	1.48%	0.00%
Chromium	1.48E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	6.89E-05	5.90E-06	5.00E-03	--	1.38E-02	–	2.92%	0.00%
Cobalt	6.40E+01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	2.98E-05	2.55E-06	6.00E-02	--	4.96E-04	–	0.11%	0.00%
Copper	3.05E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	1.42E-04	1.22E-05	3.71E-02	--	3.83E-03	–	0.81%	0.00%
Iron	9.48E+04	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	4.41E-02	3.78E-03	3.00E-01	--	1.47E-01	–	31.19%	0.00%
Manganese	1.24E+03	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	5.77E-04	4.95E-05	5.00E-03	--	1.15E-01	–	24.48%	0.00%
Mercury	7.90E-01	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	3.68E-07	3.15E-08	3.00E-04	--	1.23E-03	–	0.26%	0.00%
Nickel	1.43E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	6.66E-05	5.70E-06	2.00E-02	--	3.33E-03	–	0.71%	0.00%
Vanadium	1.62E+02	7280	0.001 ***	2.6	350	6	1E-06	15	2190	25550	7.54E-05	6.46E-06	7.00E-03	--	1.08E-02	–	2.28%	0.00%
Zinc	3.80E+03	7280	0.0006 *	2.6	350	6	1E-06	15	2190	25550	1.06E-03	9.10E-05	3.00E-01	--	3.54E-03	–	0.75%	0.00%
TOTAL															4.71E-01	4.77E-06	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE WATER
SITE 12

FUTURE SCENARIO
SURFACE WATER – DERMAL
RESIDENT ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.10E+01	23000	0.01 *	2.6	350	30	1E-06	70	10950	25550	3.47E-05	1.49E-05	9.00E-03	--	3.85E-03	–	1.21%	0.00%
Trichloroethene	3.00E+00	23000	0.23 **	2.6	350	30	1E-06	70	10950	25550	2.17E-04	9.32E-05	6.00E-03	1.10E-02	3.62E-02	1.02E-06	11.35%	6.35%
Tetrachloroethene	3.00E+00	23000	0.37 **	2.6	350	30	1E-06	70	10950	25550	3.50E-04	1.50E-04	1.00E-02	5.20E-02	3.50E-02	7.79E-06	10.96%	48.26%
Aluminum	8.18E+04	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.58E-02	1.10E-02	2.90E+00	--	8.89E-03	–	2.78%	0.00%
Arsenic	2.34E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	7.37E-06	3.16E-06	3.00E-04	1.75E+00	2.46E-02	5.53E-06	7.70%	34.24%
Barium	6.69E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.11E-04	9.03E-05	7.00E-02	--	3.01E-03	–	0.94%	0.00%
Beryllium	3.10E+00	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	9.77E-07	4.19E-07	5.00E-03	4.30E+00	1.95E-04	1.80E-06	0.06%	11.15%
Cadmium	7.50E+00	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.36E-06	1.01E-06	5.00E-04	--	4.73E-03	–	1.48%	0.00%
Chromium	1.48E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	4.66E-05	2.00E-05	5.00E-03	--	9.33E-03	–	2.92%	0.00%
Cobalt	6.40E+01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.02E-05	8.64E-06	6.00E-02	--	3.36E-04	–	0.11%	0.00%
Copper	3.05E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	9.61E-05	4.12E-05	3.71E-02	--	2.59E-03	–	0.81%	0.00%
Iron	9.48E+04	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.99E-02	1.28E-02	3.00E-01	--	9.96E-02	–	31.19%	0.00%
Manganese	1.24E+03	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	3.91E-04	1.67E-04	5.00E-03	--	7.81E-02	–	24.48%	0.00%
Mercury	7.90E-01	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	2.49E-07	1.07E-07	3.00E-04	--	8.30E-04	–	0.26%	0.00%
Nickel	1.43E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	4.51E-05	1.93E-05	2.00E-02	--	2.25E-03	–	0.71%	0.00%
Vanadium	1.62E+02	23000	0.001 ***	2.6	350	30	1E-06	70	10950	25550	5.10E-05	2.19E-05	7.00E-03	--	7.29E-03	–	2.28%	0.00%
Zinc	3.80E+03	23000	0.0006 *	2.6	350	30	1E-06	70	10950	25550	7.18E-04	3.08E-04	3.00E-01	--	2.39E-03	–	0.75%	0.00%
TOTAL															3.19E-01	1.61E-05	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

CONSTITUENTS DETECTED IN SEDIMENTS
SITE 12
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)			Residential Soil Conc. (ug/kg) [a]	Potential Concern
VOLATILES						
Acetone	3 / 4	8 j	–	82 j	0.78	NO
1,2–Dichloroethene (total)	2 / 4	2 j	–	14 j	0.07	YES
Trichloroethene	2 / 4	3 j	–	19 j	0.058	YES
Tetrachloroethene	2 / 4	6 j	–	15 j	0.012	YES
Toluene	1 / 4		5 j		1.6	YES
Xylene (total)	1 / 4		4 j		16	NO
INORGANICS						
Aluminum	4 / 4	1130000	–	1E+07 j	2.30E+07	YES
Arsenic [b]	4 / 4	640 b	–	5600 b	3.70E+02	YES
Barium [b]	4 / 4	3400 b	–	72000 b	5.50E+05	YES
Cadmium [b]	1 / 4		1200 b		3.90E+04	YES
Calcium	4 / 4	72500 b	–	3E+06 b		NO
Chromium	4 / 4	1300 b	–	20600	3.90E+04	YES
Cobalt [b]	3 / 4	1300 b	–	4800 b	4.70E+05	YES
Copper	4 / 4	2300 b	–	36000	2.90E+05	YES
Iron	4 / 4	1220000	–	129000		YES
Lead	4 / 4	8700	–	110000		YES*
Magnesium	4 / 4	83600 b	–	2E+06 b		NO
Manganese	4 / 4	3700	–	144000	3.90E+04	YES
Mercury	1 / 4		280		2.30E+03	YES
Nickel [b]	3 / 4	2900 b	–	13800 b	1.60E+05	YES
Potassium	4 / 4	45800 b	–	1E+06 b		NO
Sodium	1 / 4		346000 b			NO
Vanadium [b]	4 / 4	1900 b	–	26900 b	5.50E+04	YES
Zinc	4 / 4	6100	–	383000	2.30E+06	YES

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum where it is obtained from the January 11, 1994 RBC Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

b. Constituent concentration is five times greater than the maximum detected in blank (b).

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SEDIMENT
SITE 12

CURRENT SCENARIO
SEDIMENT – INGESTION
TRESPASSER CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.40E−02	100	1	14	6	1E−06	15	2190	25550	3.58E−09	3.07E−10	9.00E−03	--	3.98E−07	--	0.00%	0.00%
Trichloroethene	1.90E−02	100	1	14	6	1E−06	15	2190	25550	4.86E−09	4.16E−10	6.00E−03	1.10E−02	8.10E−07	4.58E−12	0.00%	0.00%
Tetrachloroethene	1.50E−02	100	1	14	6	1E−06	15	2190	25550	3.84E−09	3.29E−10	1.00E−02	5.20E−02	3.84E−07	1.71E−11	0.00%	0.01%
Aluminum	1.00E+04	100	1	14	6	1E−06	15	2190	25550	2.56E−03	2.19E−04	2.90E+00	--	8.82E−04	--	5.17%	0.00%
Arsenic	5.60E+00	100	1	14	6	1E−06	15	2190	25550	1.43E−06	1.23E−07	3.00E−04	1.75E+00	4.77E−03	2.15E−07	27.99%	99.99%
Barium	7.20E+01	100	1	14	6	1E−06	15	2190	25550	1.84E−05	1.58E−06	7.00E−02	--	2.63E−04	--	1.54%	0.00%
Cadmium	1.20E+00	100	1	14	6	1E−06	15	2190	25550	3.07E−07	2.63E−08	5.00E−04	--	6.14E−04	--	3.60%	0.00%
Chromium	2.06E+01	100	1	14	6	1E−06	15	2190	25550	5.27E−06	4.52E−07	5.00E−03	--	1.05E−03	--	6.18%	0.00%
Cobalt	4.80E+00	100	1	14	6	1E−06	15	2190	25550	1.23E−06	1.05E−07	6.00E−02	--	2.05E−05	--	0.12%	0.00%
Copper	3.60E+01	100	1	14	6	1E−06	15	2190	25550	9.21E−06	7.89E−07	3.71E−02	--	2.48E−04	--	1.45%	0.00%
Iron	1.29E+02	100	1	14	6	1E−06	15	2190	25550	3.30E−05	2.83E−06	3.00E−01	--	1.10E−04	--	0.64%	0.00%
Manganese	1.44E+02	100	1	14	6	1E−06	15	2190	25550	3.68E−05	3.16E−06	5.00E−03	--	7.36E−03	--	43.18%	0.00%
Mercury	2.80E−01	100	1	14	6	1E−06	15	2190	25550	7.16E−08	6.14E−09	3.00E−04	--	2.39E−04	--	1.40%	0.00%
Nickel	1.38E+01	100	1	14	6	1E−06	15	2190	25550	3.53E−06	3.02E−07	2.00E−02	--	1.76E−04	--	1.03%	0.00%
Vanadium	2.69E+01	100	1	14	6	1E−06	15	2190	25550	6.88E−06	5.90E−07	7.00E−03	--	9.83E−04	--	5.76%	0.00%
Zinc	3.83E+02	100	1	14	6	1E−06	15	2190	25550	9.79E−05	8.39E−06	3.00E−01	--	3.26E−04	--	1.91%	0.00%
TOTAL														1.71E−02	2.15E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SEDIMENT
SITE 12

CURRENT SCENARIO
SEDIMENT – INGESTION
TRESPASSER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2−Dichloroethene	1.40E−02	50	1	28	30	1E−06	70	10950	25550	7.67E−10	3.29E−10	9.00E−03	--	8.52E−08	--	0.00%	0.00%
Trichloroethene	1.90E−02	50	1	28	30	1E−06	70	10950	25550	1.04E−09	4.46E−10	6.00E−03	1.10E−02	1.74E−07	4.91E−12	0.00%	0.00%
Tetrachloroethene	1.50E−02	50	1	28	30	1E−06	70	10950	25550	8.22E−10	3.52E−10	1.00E−02	5.20E−02	8.22E−08	1.83E−11	0.00%	0.01%
Aluminum	1.00E+04	50	1	28	30	1E−06	70	10950	25550	5.48E−04	2.35E−04	2.90E+00	--	1.89E−04	--	5.17%	0.00%
Arsenic	5.60E+00	50	1	28	30	1E−06	70	10950	25550	3.07E−07	1.32E−07	3.00E−04	1.75E+00	1.02E−03	2.30E−07	27.99%	99.99%
Barium	7.20E+01	50	1	28	30	1E−06	70	10950	25550	3.95E−06	1.69E−06	7.00E−02	--	5.64E−05	--	1.54%	0.00%
Cadmium	1.20E+00	50	1	28	30	1E−06	70	10950	25550	6.58E−08	2.82E−08	5.00E−04	--	1.32E−04	--	3.60%	0.00%
Chromium	2.06E+01	50	1	28	30	1E−06	70	10950	25550	1.13E−06	4.84E−07	5.00E−03	--	2.26E−04	--	6.18%	0.00%
Cobalt	4.80E+00	50	1	28	30	1E−06	70	10950	25550	2.63E−07	1.13E−07	6.00E−02	--	4.38E−06	--	0.12%	0.00%
Copper	3.60E+01	50	1	28	30	1E−06	70	10950	25550	1.97E−06	8.45E−07	3.71E−02	--	5.32E−05	--	1.45%	0.00%
Iron	1.29E+02	50	1	28	30	1E−06	70	10950	25550	7.07E−06	3.03E−06	3.00E−01	--	2.36E−05	--	0.64%	0.00%
Manganese	1.44E+02	50	1	28	30	1E−06	70	10950	25550	7.89E−06	3.38E−06	5.00E−03	--	1.58E−03	--	43.18%	0.00%
Mercury	2.80E−01	50	1	28	30	1E−06	70	10950	25550	1.53E−08	6.58E−09	3.00E−04	--	5.11E−05	--	1.40%	0.00%
Nickel	1.38E+01	50	1	28	30	1E−06	70	10950	25550	7.56E−07	3.24E−07	2.00E−02	--	3.78E−05	--	1.03%	0.00%
Vanadium	2.69E+01	50	1	28	30	1E−06	70	10950	25550	1.47E−06	6.32E−07	7.00E−03	--	2.11E−04	--	5.76%	0.00%
Zinc	3.83E+02	50	1	28	30	1E−06	70	10950	25550	2.10E−05	8.99E−06	3.00E−01	--	7.00E−05	--	1.91%	0.00%
TOTAL														3.65E−03	2.30E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SEDIMENT
SITE 12

CURRENT SCENARIO
SEDIMENT – INGESTION
WORKER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.40E−02	50	1	250	25	1E−06	70	9125	25550	6.85E−09	2.45E−09	9.00E−03	--	7.61E−07	--	0.00%	0.00%
Trichloroethene	1.90E−02	50	1	250	25	1E−06	70	9125	25550	9.30E−09	3.32E−09	6.00E−03	1.10E−02	1.55E−06	3.65E−11	0.00%	0.00%
Tetrachloroethene	1.50E−02	50	1	250	25	1E−06	70	9125	25550	7.34E−09	2.62E−09	1.00E−02	5.20E−02	7.34E−07	1.36E−10	0.00%	0.01%
Aluminum	1.00E+04	50	1	250	25	1E−06	70	9125	25550	4.89E−03	1.75E−03	2.90E+00	--	1.69E−03	--	5.17%	0.00%
Arsenic	5.60E+00	50	1	250	25	1E−06	70	9125	25550	2.74E−06	9.78E−07	3.00E−04	1.75E+00	9.13E−03	1.71E−06	27.99%	99.99%
Barium	7.20E+01	50	1	250	25	1E−06	70	9125	25550	3.52E−05	1.26E−05	7.00E−02	--	5.03E−04	--	1.54%	0.00%
Cadmium	1.20E+00	50	1	250	25	1E−06	70	9125	25550	5.87E−07	2.10E−07	5.00E−04	--	1.17E−03	--	3.60%	0.00%
Chromium	2.06E+01	50	1	250	25	1E−06	70	9125	25550	1.01E−05	3.60E−06	5.00E−03	--	2.02E−03	--	6.18%	0.00%
Cobalt	4.80E+00	50	1	250	25	1E−06	70	9125	25550	2.35E−06	8.39E−07	6.00E−02	--	3.91E−05	--	0.12%	0.00%
Copper	3.60E+01	50	1	250	25	1E−06	70	9125	25550	1.76E−05	6.29E−06	3.71E−02	--	4.75E−04	--	1.45%	0.00%
Iron	1.29E+02	50	1	250	25	1E−06	70	9125	25550	6.31E−05	2.25E−05	3.00E−01	--	2.10E−04	--	0.64%	0.00%
Manganese	1.44E+02	50	1	250	25	1E−06	70	9125	25550	7.05E−05	2.52E−05	5.00E−03	--	1.41E−02	--	43.16%	0.00%
Mercury	2.80E−01	50	1	250	25	1E−06	70	9125	25550	1.37E−07	4.89E−08	3.00E−04	--	4.57E−04	--	1.40%	0.00%
Nickel	1.38E+01	50	1	250	25	1E−06	70	9125	25550	6.75E−06	2.41E−06	2.00E−02	--	3.38E−04	--	1.03%	0.00%
Vanadium	2.69E+01	50	1	250	25	1E−06	70	9125	25550	1.32E−05	4.70E−06	7.00E−03	--	1.88E−03	--	5.76%	0.00%
Zinc	3.83E+02	50	1	250	25	1E−06	70	9125	25550	1.87E−04	6.69E−05	3.00E−01	--	6.25E−04	--	1.91%	0.00%
TOTAL														3.26E−02	1.71E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SEDIMENT
SITE 12

CURRENT SCENARIO
SEDIMENT – DERMAL
TRESPASSER CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2−Dichloroethene	1.40E−02	1820	1	0.01	14	6	1E−06	15	2190	25550	6.52E−10	5.58E−11	9.00E−03	−−	7.24E−08	−	0.02%	0.00%
Trichloroethene	1.90E−02	1820	1	0.01	14	6	1E−06	15	2190	25550	8.84E−10	7.58E−11	6.00E−03	1.10E−02	1.47E−07	8.34E−13	0.05%	0.02%
Tetrachloroethene	1.50E−02	1820	1	0.01	14	6	1E−06	15	2190	25550	6.98E−10	5.98E−11	1.00E−02	5.20E−02	6.98E−08	3.11E−12	0.02%	0.08%
Aluminum	1.00E+04	1820	1	0.001	14	6	1E−06	15	2190	25550	4.65E−05	3.99E−06	2.90E+00	−−	1.60E−05	−	5.17%	0.00%
Arsenic	5.60E+00	1820	1	0.001	14	6	1E−06	15	2190	25550	2.61E−08	2.23E−09	3.00E−04	1.75E+00	8.69E−05	3.91E−09	27.97%	99.90%
Barium	7.20E+01	1820	1	0.001	14	6	1E−06	15	2190	25550	3.35E−07	2.87E−08	7.00E−02	−−	4.79E−06	−	1.54%	0.00%
Cadmium	1.20E+00	1820	1	0.001	14	6	1E−06	15	2190	25550	5.58E−09	4.79E−10	5.00E−04	−−	1.12E−05	−	3.60%	0.00%
Chromium	2.06E+01	1820	1	0.001	14	6	1E−06	15	2190	25550	9.59E−08	8.22E−09	5.00E−03	−−	1.92E−05	−	6.17%	0.00%
Cobalt	4.80E+00	1820	1	0.001	14	6	1E−06	15	2190	25550	2.23E−08	1.91E−09	6.00E−02	−−	3.72E−07	−	0.12%	0.00%
Copper	3.60E+01	1820	1	0.001	14	6	1E−06	15	2190	25550	1.68E−07	1.44E−08	3.71E−02	−−	4.52E−06	−	1.45%	0.00%
Iron	1.29E+02	1820	1	0.001	14	6	1E−06	15	2190	25550	6.00E−07	5.15E−08	3.00E−01	−−	2.00E−06	−	0.64%	0.00%
Manganese	1.44E+02	1820	1	0.001	14	6	1E−06	15	2190	25550	6.70E−07	5.74E−08	5.00E−03	−−	1.34E−04	−	43.15%	0.00%
Mercury	2.80E−01	1820	1	0.001	14	6	1E−06	15	2190	25550	1.30E−09	1.12E−10	3.00E−04	−−	4.34E−06	−	1.40%	0.00%
Nickel	1.38E+01	1820	1	0.001	14	6	1E−06	15	2190	25550	6.42E−08	5.50E−09	2.00E−02	−−	3.21E−06	−	1.03%	0.00%
Vanadium	2.69E+01	1820	1	0.001	14	6	1E−06	15	2190	25550	1.25E−07	1.07E−08	7.00E−03	−−	1.79E−05	−	5.76%	0.00%
Zinc	3.83E+02	1820	1	0.001	14	6	1E−06	15	2190	25550	1.78E−06	1.53E−07	3.00E−01	−−	5.94E−06	−	1.91%	0.00%
TOTAL															3.11E−04	3.91E−09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SEDIMENT
SITE 12

CURRENT SCENARIO
SEDIMENT -- DERMAL
TRESPASSER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.40E-02	5800	1	0.01	28	30	1E-06	70	10950	25550	8.90E-10	3.81E-10	9.00E-03	--	9.89E-08	-	0.02%	0.00%
Trichloroethene	1.90E-02	5800	1	0.01	28	30	1E-06	70	10950	25550	1.21E-09	5.18E-10	6.00E-03	1.10E-02	2.01E-07	5.69E-12	0.05%	0.02%
Tetrachloroethene	1.50E-02	5800	1	0.01	28	30	1E-06	70	10950	25550	9.53E-10	4.09E-10	1.00E-02	5.20E-02	9.53E-08	2.12E-11	0.02%	0.08%
Aluminum	1.00E+04	5800	1	0.001	28	30	1E-06	70	10950	25550	6.36E-05	2.72E-05	2.90E+00	---	2.19E-05		5.17%	0.00%
Arsenic	5.60E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	3.56E-08	1.53E-08	3.00E-04	1.75E+00	1.19E-04	2.67E-08	27.97%	99.90%
Barium	7.20E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	4.58E-07	1.96E-07	7.00E-02	--	6.54E-06	-	1.54%	0.00%
Cadmium	1.20E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	7.63E-09	3.27E-09	5.00E-04	--	1.53E-05	-	3.60%	0.00%
Chromium	2.06E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.31E-07	5.61E-08	5.00E-03	--	2.62E-05	-	6.17%	0.00%
Cobalt	4.80E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	3.05E-08	1.31E-08	6.00E-02	--	5.08E-07	-	0.12%	0.00%
Copper	3.60E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	2.29E-07	9.81E-08	3.71E-02	--	6.17E-06	-	1.45%	0.00%
Iron	1.29E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	8.20E-07	3.51E-07	3.00E-01	--	2.73E-06	-	0.64%	0.00%
Manganese	1.44E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	9.15E-07	3.92E-07	5.00E-03	--	1.83E-04	-	43.15%	0.00%
Mercury	2.80E-01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.78E-09	7.63E-10	3.00E-04	--	5.93E-06	-	1.40%	0.00%
Nickel	1.38E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	8.77E-08	3.76E-08	2.00E-02	--	4.39E-06	-	1.03%	0.00%
Vanadium	2.69E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.71E-07	7.33E-08	7.00E-03	--	2.44E-05	-	5.76%	0.00%
Zinc	3.83E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	2.43E-06	1.04E-06	3.00E-01	--	8.11E-06	-	1.91%	0.00%
TOTAL															4.24E-04	2.67E-08	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SEDIMENT
SITE 12

CURRENT SCENARIO
SEDIMENT – DERMAL
WORKER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.40E-02	5800	1	0.01	250	25	1E-06	70	9125	25550	7.95E-09	2.84E-09	9.00E-03	--	8.83E-07	–	0.02%	0.00%
Trichloroethene	1.90E-02	5800	1	0.01	250	25	1E-06	70	9125	25550	1.08E-08	3.85E-09	6.00E-03	1.10E-02	1.80E-06	4.24E-11	0.05%	0.02%
Tetrachloroethene	1.50E-02	5800	1	0.01	250	25	1E-06	70	9125	25550	8.51E-09	3.04E-09	1.00E-02	5.20E-02	8.51E-07	1.58E-10	0.02%	0.08%
Aluminum	1.00E+04	5800	1	0.001	250	25	1E-06	70	9125	25550	5.68E-04	2.03E-04	2.90E+00	--	1.96E-04	–	5.17%	0.00%
Arsenic	5.60E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	3.18E-07	1.14E-07	3.00E-04	1.75E+00	1.06E-03	1.99E-07	27.97%	99.90%
Barium	7.20E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	4.09E-06	1.46E-06	7.00E-02	--	5.84E-05	–	1.54%	0.00%
Cadmium	1.20E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	6.81E-08	2.43E-08	5.00E-04	--	1.36E-04	–	3.60%	0.00%
Chromium	2.06E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	1.17E-06	4.18E-07	5.00E-03	--	2.34E-04	–	6.17%	0.00%
Cobalt	4.80E+00	5800	1	0.001	250	25	1E-06	70	9125	25550	2.72E-07	9.73E-08	6.00E-02	--	4.54E-06	–	0.12%	0.00%
Copper	3.60E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	2.04E-06	7.30E-07	3.71E-02	--	5.51E-05	–	1.45%	0.00%
Iron	1.29E+02	5800	1	0.001	250	25	1E-06	70	9125	25550	7.32E-06	2.61E-06	3.00E-01	-	2.44E-05		0.64%	0.00%
Manganese	1.44E+02	5800	1	0.001	250	25	1E-06	70	9125	25550	8.17E-06	2.92E-06	5.00E-03	--	1.63E-03	–	43.15%	0.00%
Mercury	2.80E-01	5800	1	0.001	250	25	1E-06	70	9125	25550	1.59E-08	5.68E-09	3.00E-04	--	5.30E-05	–	1.40%	0.00%
Nickel	1.38E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	7.83E-07	2.80E-07	2.00E-02	--	3.92E-05	–	1.03%	0.00%
Vanadium	2.69E+01	5800	1	0.001	250	25	1E-06	70	9125	25550	1.53E-06	5.45E-07	7.00E-03	--	2.18E-04	–	5.76%	0.00%
Zinc	3.83E+02	5800	1	0.001	250	25	1E-06	70	9125	25550	2.17E-05	7.76E-06	3.00E-01	--	7.25E-05	–	1.91%	0.00%
TOTAL															3.79E-03	1.99E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SEDIMENT
SITE 12

FUTURE SCENARIO
SEDIMENT -- INGESTION
RESIDENT CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.40E-02	100	1	14	6	1E-06	15	2190	25550	3.58E-09	3.07E-10	9.00E-03	--	3.98E-07	--	0.00%	0.00%
Trichloroethene	1.90E-02	100	1	14	6	1E-06	15	2190	25550	4.86E-09	4.16E-10	6.00E-03	1.10E-02	8.10E-07	4.58E-12	0.00%	0.00%
Tetrachloroethene	1.50E-02	100	1	14	6	1E-06	15	2190	25550	3.84E-09	3.29E-10	1.00E-02	5.20E-02	3.84E-07	1.71E-11	0.00%	0.01%
Aluminum	1.00E+04	100	1	14	6	1E-06	15	2190	25550	2.56E-03	2.19E-04	2.90E+00	--	8.82E-04	--	5.17%	0.00%
Arsenic	5.60E+00	100	1	14	6	1E-06	15	2190	25550	1.43E-06	1.23E-07	3.00E-04	1.75E+00	4.77E-03	2.15E-07	27.99%	99.99%
Barium	7.20E+01	100	1	14	6	1E-06	15	2190	25550	1.84E-05	1.58E-06	7.00E-02	--	2.63E-04	--	1.54%	0.00%
Cadmium	1.20E+00	100	1	14	6	1E-06	15	2190	25550	3.07E-07	2.63E-08	5.00E-04	--	6.14E-04	--	3.60%	0.00%
Chromium	2.06E+01	100	1	14	6	1E-06	15	2190	25550	5.27E-06	4.52E-07	5.00E-03	--	1.05E-03	--	6.18%	0.00%
Cobalt	4.80E+00	100	1	14	6	1E-06	15	2190	25550	1.23E-06	1.05E-07	6.00E-02	--	2.05E-05	--	0.12%	0.00%
Copper	3.60E+01	100	1	14	6	1E-06	15	2190	25550	9.21E-06	7.89E-07	3.71E-02	--	2.48E-04	--	1.45%	0.00%
Iron	1.29E+02	100	1	14	6	1E-06	15	2190	25550	3.30E-05	2.83E-06	3.00E-01	--	1.10E-04	--	0.64%	0.00%
Manganese	1.44E+02	100	1	14	6	1E-06	15	2190	25550	3.68E-05	3.16E-06	5.00E-03	--	7.36E-03	--	43.18%	0.00%
Mercury	2.80E-01	100	1	14	6	1E-06	15	2190	25550	7.16E-08	6.14E-09	3.00E-04	--	2.39E-04	--	1.40%	0.00%
Nickel	1.38E+01	100	1	14	6	1E-06	15	2190	25550	3.53E-06	3.02E-07	2.00E-02	--	1.76E-04	--	1.03%	0.00%
Vanadium	2.69E+01	100	1	14	6	1E-06	15	2190	25550	6.88E-06	5.90E-07	7.00E-03	--	9.83E-04	--	5.76%	0.00%
Zinc	3.83E+02	100	1	14	6	1E-06	15	2190	25550	9.79E-05	8.39E-06	3.00E-01	--	3.26E-04	--	1.91%	0.00%
TOTAL														1.71E-02	2.15E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SEDIMENT
SITE 12

FUTURE SCENARIO
SEDIMENT – INGESTION
RESIDENT ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2−Dichloroethene	1.40E−02	50	1	28	30	1E−06	70	10950	25550	7.67E−10	3.29E−10	9.00E−03	--	8.52E−08	--	0.00%	0.00%
Trichloroethene	1.90E−02	50	1	28	30	1E−06	70	10950	25550	1.04E−09	4.46E−10	6.00E−03	1.10E−02	1.74E−07	4.91E−12	0.00%	0.00%
Tetrachloroethene	1.50E−02	50	1	28	30	1E−06	70	10950	25550	8.22E−10	3.52E−10	1.00E−02	5.20E−02	8.22E−08	1.83E−11	0.00%	0.01%
Aluminum	1.00E+04	50	1	28	30	1E−06	70	10950	25550	5.48E−04	2.35E−04	2.90E+00	--	1.89E−04	--	5.17%	0.00%
Arsenic	5.60E+00	50	1	28	30	1E−06	70	10950	25550	3.07E−07	1.32E−07	3.00E−04	1.75E+00	1.02E−03	2.30E−07	27.99%	99.99%
Barium	7.20E+01	50	1	28	30	1E−06	70	10950	25550	3.95E−06	1.69E−06	7.00E−02	--	5.64E−05	--	1.54%	0.00%
Cadmium	1.20E+00	50	1	28	30	1E−06	70	10950	25550	6.58E−08	2.82E−08	5.00E−04	--	1.32E−04	--	3.60%	0.00%
Chromium	2.06E+01	50	1	28	30	1E−06	70	10950	25550	1.13E−06	4.84E−07	5.00E−03	--	2.26E−04	--	6.18%	0.00%
Cobalt	4.80E+00	50	1	28	30	1E−06	70	10950	25550	2.63E−07	1.13E−07	6.00E−02	--	4.38E−06	--	0.12%	0.00%
Copper	3.60E+01	50	1	28	30	1E−06	70	10950	25550	1.97E−06	8.45E−07	3.71E−02	--	5.32E−05	--	1.45%	0.00%
Iron	1.29E+02	50	1	28	30	1E−06	70	10950	25550	7.07E−06	3.03E−06	3.00E−01	--	2.36E−05	--	0.64%	0.00%
Manganese	1.44E+02	50	1	28	30	1E−06	70	10950	25550	7.89E−06	3.38E−06	5.00E−03	--	1.58E−03	--	43.18%	0.00%
Mercury	2.80E−01	50	1	28	30	1E−06	70	10950	25550	1.53E−08	6.58E−09	3.00E−04	--	5.11E−05	--	1.40%	0.00%
Nickel	1.38E+01	50	1	28	30	1E−06	70	10950	25550	7.56E−07	3.24E−07	2.00E−02	--	3.78E−05	--	1.03%	0.00%
Vanadium	2.69E+01	50	1	28	30	1E−06	70	10950	25550	1.47E−06	6.32E−07	7.00E−03	--	2.11E−04	--	5.76%	0.00%
Zinc	3.83E+02	50	1	28	30	1E−06	70	10950	25550	2.10E−05	8.99E−06	3.00E−01	--	7.00E−05	--	1.91%	0.00%
TOTAL														3.65E−03	2.30E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SEDIMENT
SITE 12

FUTURE SCENARIO
SEDIMENT – DERMAL
RESIDENT CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.40E-02	1820	1	0.01	14	6	1E-06	15	2190	25550	6.52E-10	5.58E-11	9.00E-03	--	7.24E-08	–	0.02%	0.00%
Trichloroethene	1.90E-02	1820	1	0.01	14	6	1E-06	15	2190	25550	8.84E-10	7.58E-11	6.00E-03	1.10E-02	1.47E-07	8.34E-13	0.05%	0.02%
Tetrachloroethene	1.50E-02	1820	1	0.01	14	6	1E-06	15	2190	25550	6.98E-10	5.98E-11	1.00E-02	5.20E-02	6.98E-08	3.11E-12	0.02%	0.08%
Aluminum	1.00E+04	1820	1	0.001	14	6	1E-06	15	2190	25550	4.65E-05	3.99E-06	2.90E+00	--	1.60E-05	–	5.17%	0.00%
Arsenic	5.60E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	2.61E-08	2.23E-09	3.00E-04	1.75E+00	8.69E-05	3.91E-09	27.97%	99.90%
Barium	7.20E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	3.35E-07	2.87E-08	7.00E-02	--	4.79E-06	–	1.54%	0.00%
Cadmium	1.20E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	5.58E-09	4.79E-10	5.00E-04	--	1.12E-05	–	3.60%	0.00%
Chromium	2.06E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	9.59E-08	8.22E-09	5.00E-03	--	1.92E-05	–	6.17%	0.00%
Cobalt	4.80E+00	1820	1	0.001	14	6	1E-06	15	2190	25550	2.23E-08	1.91E-09	6.00E-02	--	3.72E-07	–	0.12%	0.00%
Copper	3.60E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.68E-07	1.44E-08	3.71E-02	--	4.52E-06	–	1.45%	0.00%
Iron	1.20E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	6.00E-07	5.15E-08	3.00E-01	--	2.00E-08		0.64%	0.00%
Manganese	1.44E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	6.70E-07	5.74E-08	5.00E-03	--	1.34E-04	–	43.15%	0.00%
Mercury	2.80E-01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.30E-09	1.12E-10	3.00E-04	--	4.34E-06	–	1.40%	0.00%
Nickel	1.38E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	6.42E-08	5.50E-09	2.00E-02	--	3.21E-06	–	1.03%	0.00%
Vanadium	2.69E+01	1820	1	0.001	14	6	1E-06	15	2190	25550	1.25E-07	1.07E-08	7.00E-03	--	1.79E-05	–	5.76%	0.00%
Zinc	3.83E+02	1820	1	0.001	14	6	1E-06	15	2190	25550	1.78E-06	1.53E-07	3.00E-01	--	5.94E-06	–	1.91%	0.00%
TOTAL															3.11E-04	3.91E-09	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SEDIMENT
SITE 12

FUTURE SCENARIO
SEDIMENT – DERMAL
RESIDENT ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
1,2-Dichloroethene	1.40E-02	5800	1	0.01	28	30	1E-06	70	10950	25550	8.90E-10	3.81E-10	9.00E-03	--	9.89E-08	–	0.02%	0.00%
Trichloroethene	1.90E-02	5800	1	0.01	28	30	1E-06	70	10950	25550	1.21E-09	5.18E-10	6.00E-03	1.10E-02	2.01E-07	5.69E-12	0.05%	0.02%
Tetrachloroethene	1.50E-02	5800	1	0.01	28	30	1E-06	70	10950	25550	9.53E-10	4.09E-10	1.00E-02	5.20E-02	9.53E-08	2.12E-11	0.02%	0.08%
Aluminum	1.00E+04	5800	1	0.001	28	30	1E-06	70	10950	25550	6.36E-05	2.72E-05	2.90E+00	--	2.19E-05	–	5.17%	0.00%
Arsenic	5.60E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	3.56E-08	1.53E-08	3.00E-04	1.75E+00	1.19E-04	2.67E-08	27.97%	99.90%
Barium	7.20E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	4.58E-07	1.96E-07	7.00E-02	--	6.54E-06	–	1.54%	0.00%
Cadmium	1.20E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	7.63E-09	3.27E-09	5.00E-04	--	1.53E-05	–	3.60%	0.00%
Chromium	2.06E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.31E-07	5.61E-08	5.00E-03	--	2.62E-05	–	6.17%	0.00%
Cobalt	4.80E+00	5800	1	0.001	28	30	1E-06	70	10950	25550	3.05E-08	1.31E-08	6.00E-02	--	5.08E-07	–	0.12%	0.00%
Copper	3.60E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	2.29E-07	9.81E-08	3.71E-02	--	6.17E-06	–	1.45%	0.00%
Iron	1.29E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	8.20E-07	3.51E-07	3.00E-01	--	2.73E-06	–	0.64%	0.00%
Manganese	1.44E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	9.15E-07	3.92E-07	5.00E-03	--	1.83E-04	–	43.15%	0.00%
Mercury	2.80E-01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.78E-09	7.63E-10	3.00E-04	--	5.93E-06	–	1.40%	0.00%
Nickel	1.38E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	8.77E-08	3.76E-08	2.00E-02	--	4.39E-06	–	1.03%	0.00%
Vanadium	2.69E+01	5800	1	0.001	28	30	1E-06	70	10950	25550	1.71E-07	7.33E-08	7.00E-03	--	2.44E-05	–	5.76%	0.00%
Zinc	3.83E+02	5800	1	0.001	28	30	1E-06	70	10950	25550	2.43E-06	1.04E-06	3.00E-01	--	8.11E-06	–	1.91%	0.00%
TOTAL															4.24E-04	2.67E-08	100.00%	100.00%

CONSTITUENTS DETECTED IN SURFACE WATER
SITE 12
AVAILABLE FOR FISH CONSUMPTION
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)			Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Water Stds. (ug/l) [d]	Potential Concern
VOLATILES									
Acetone	3 / 4	20	–	50		370			NO
1,2–Dichloroethene (total)	1 / 4		11			5.5	70		YES
2–Butanone	1 / 4		36						NO
Trichloroethene	1 / 4		3 j		5	1.6	300	27	YES
Tetrachloroethene	1 / 4		3 j		0.8	1.1	5	318	YES
Toluene	3 / 4	2 j	–	58	6800	750	1000	6800	NO
INORGANICS									
Aluminum	2 / 4	4320j	–	81800 j		11000			YES
Arsenic	3 / 4	2.2 j	–	23.4 j	0.018	0.038	50	50	YES
Barium	4 / 4	25.3 j	–	669 j		260	2000	2000	YES
Beryllium	1 / 4		3.1 j			0.016	4		YES
Cadmium	1 / 4		7.5 j			18	5	16	YES
Calcium	4 / 4	15600 j	–	84500 j					NO
Chromium	1 / 4		148 j			18	100	170	YES
Cobalt	1 / 4		64 j			220			YES
Copper	4 / 4	4.7 j	–	305 j		140	1300	1300	YES
Iron	4 / 4	2900 j	–	94800 j				300	YES
Lead	4 / 4	2.0 j	–	312 j			0	15	YES *
Magnesium	4 / 4	5150 j	–	26600 j					NO
Manganese	4 / 4	507 j	–	1240 j		18		50	YES
Mercury	1 / 4		0.79 j		0.14	1.1	2	0.144	YES
Nickel	1 / 4		143 j		610	73	100	607	YES
Potassium	4 / 4	2800 j	–	21300 j					NO
Sodium	4 / 4	13300 j	–	262000 j					NO
Vanadium	2 / 4	11.8 j	–	162 j		26			YES
Zinc	4 / 4	39.1j	–	3800 j		1100		5000	YES

Notes:

a. Federal MCL concentration values represent USFederal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table except for aluminum which is obtained from the January 7, 1994 RBC table.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Water Standards for public water supplies.

* Health risk analysis to be performed will use the Integrated Exposure Uptake Biokinetic (IEUBK) Model.

CONSTITUENTS CONCENTRATION IN FISH
SITE 12
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Maximum Detected Concentrations (ug/l)	(mg/l)	Bioconcentration Factor* (l/kg)	Fish Concentration (mg/kg)	Fish** Stds. (mg/kg)	Pot Cor
VOLATILES						
1,2–Dichloroethene (total)	11	1.10E–02	1.6	1.76E–02	1.20E+00	NC
Trichloroethene	3 j	3.00E–03 j	10.6	3.18E–02	2.90E–01	NC
Tetrachloroethene	3 j	3.00E–03 j	31	9.30E–02	6.10E–02	YE
INORGANICS						
Aluminum	81800 j	8.18E+01 j	--	--	--	*
Arsenic	23.4 j	2.34E–02 j	44	1.03E+00	1.80E–03	YE
Barium	669 j	6.69E–01 j	--	--	--	*
Beryllium	3.1 j	3.10E–03 j	19	5.89E–02	7.30E–04	YE
Cadmium	7.5 j	7.50E–03 j	81	6.07E–01	6.80E–01	NC
Chromium	148 j	1.48E–01 j	16	2.37E+00	6.80E+00	NC
Cobalt	64 j	6.40E–02 j	--	--	--	*
Copper	305 j	3.05E–01 j	200	6.10E+01	5.00E+01	YE
Iron	94800 j	9.48E+01 j	--	--	--	*
Lead	312 j	3.12E–01 j	49	1.53E+01	5.00E+01	NC
Manganese	1240 j	1.24E+00 j	--	--	--	*
Mercury	0.79 j	7.90E–04 j	5500	4.34E+00	4.10E–01	YE
Nickel	143 j	1.43E–01 j	47	6.72E+00	2.70E+01	NC
Vanadium	162 j	1.62E–01 j	--	--	--	*
Zinc	3800 j	3.80E+00 j	47	1.79E+02	4.10E+01	YE

* Source: USEPA Superfund Public Health Evaluation Manual, EPA/540/1–86/060, October 1986

** Fish Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table.

*** Not evaluated due to unavailable bioconcentration factor.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF FISH
SITE 12

FUTURE SCENARIO
FISH – INGESTION
RESIDENT CHILD

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Tetrachloroethene	9.30E−02	6.5	1	350	6	1E−03	15	2190	25550	3.86E−05	3.31E−06	1.00E−02	5.20E−02	3.86E−03	1.72E−07	0.05%	0.23%
Arsenic	1.03E+00	6.5	1	350	6	1E−03	15	2190	25550	4.28E−04	3.67E−05	3.00E−04	1.75E+00	1.43E+00	6.42E−05	17.03%	87.47%
Beryllium	5.89E−02	6.5	1	350	6	1E−03	15	2190	25550	2.45E−05	2.10E−06	5.00E−03	4.30E+00	4.89E−03	9.02E−06	0.06%	12.29%
Copper	6.10E+01	6.5	1	350	6	1E−03	15	2190	25550	2.53E−02	2.17E−03	3.71E−02	Not Available	6.83E−01	0.00E+00	8.15%	0.00%
Mercury	4.34E+00	6.5	1	350	6	1E−03	15	2190	25550	1.80E−03	1.55E−04	3.00E−04	Not Available	6.01E+00	0.00E+00	71.75%	0.00%
Zinc	1.79E+02	6.5	1	350	6	1E−03	15	2190	25550	7.44E−02	6.38E−03	3.00E−01	Not Available	2.48E−01	0.00E+00	2.96%	0.00%
TOTAL														8.38E+00	7.34E−05	100.00%	100.00%

FUTURE SCENARIO
FISH – INGESTION
RESIDENT ADULT

CHEMICAL	FC mg/kg	IR g/d	FI	EF d/y	ED y	CF kg/g	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Tetrachloroethene	9.30E−02	6.5	1	350	30	1E−03	70	10950	25550	8.28E−06	3.55E−06	1.00E−02	5.20E−02	8.28E−04	1.85E−07	0.05%	0.23%
Arsenic	1.03E+00	6.5	1	350	30	1E−03	70	10950	25550	9.17E−05	3.93E−05	3.00E−04	1.75E+00	3.06E−01	6.88E−05	17.03%	87.47%
Beryllium	5.89E−02	6.5	1	350	30	1E−03	70	10950	25550	5.24E−06	2.25E−06	5.00E−03	4.30E+00	1.05E−03	9.66E−06	0.06%	12.29%
Copper	6.10E+01	6.5	1	350	30	1E−03	70	10950	25550	5.43E−03	2.33E−03	3.71E−02	Not Available	1.46E−01	0.00E+00	8.15%	0.00%
Mercury	4.34E+00	6.5	1	350	30	1E−03	70	10950	25550	3.86E−04	1.66E−04	3.00E−04	Not Available	1.29E+00	0.00E+00	71.75%	0.00%
Zinc	1.79E+02	6.5	1	350	30	1E−03	70	10950	25550	1.59E−02	6.83E−03	3.00E−01	Not Available	5.31E−02	0.00E+00	2.96%	0.00%
TOTAL														1.80E+00	7.86E−05	100.00%	100.00%

IEUBK MODEL OPTIONS
SITE - 12

Parameter	Default Option	User Defined Option
Air		
Outdoor air lead concentration ($\mu g/m^3$)	0.10	0.00
Ratio of indoor to outdoor air lead concentration (%)	30	00
Time outdoors (hours/day)		
Age =		
0-1 year (0-11 mo)	1	1
1-2 years (12-23 mo)	2	2
2-3 years (24-35 mo)	3	3
3-7 years (36-83 mo)	4	4
Ventilation rate (m^2/day)		
Age =		
0-1 year (0-11 mo)	2	2
1-2 years (12-23 mo)	3	3
2-3 years (24-35 mo)	5	5
3-4 years (36-47 mo)	5	5
4-5 years (48-59 mo)	5	5
5-6 years (60-71 mo)	7	7
6-7 years (72-84 mo)	7	7
Lung absorption (%)	32	00
Dietary lead intake ($\mu g/m^3$)		
Age =		
0-1 year (0-11 mo)	5.53	0.00
1-2 years (12-23 mo)	5.78	0.00
2-3 years (24-35 mo)	6.49	0.00
3-4 years (36-47 mo)	6.24	0.00
4-5 years (48-59 mo)	6.01	0.00
5-6 years (60-71 mo)	6.34	0.00
6-7 years (72-84 mo)	7.00	0.00
Alternate Diet Sources		
Concentration (μg Pb/g)		
home-grown fruits	0	0.000
home-grown vegetables	0	0.000
fish from fishing	0	4.190
game from hunting	0	0.000
Percent of food class (%)		
home-grown fruits	0	0
home-grown vegetables	0	0
fish from fishing	0	100
game from hunting	0	0

IEUBK MODEL OPTIONS

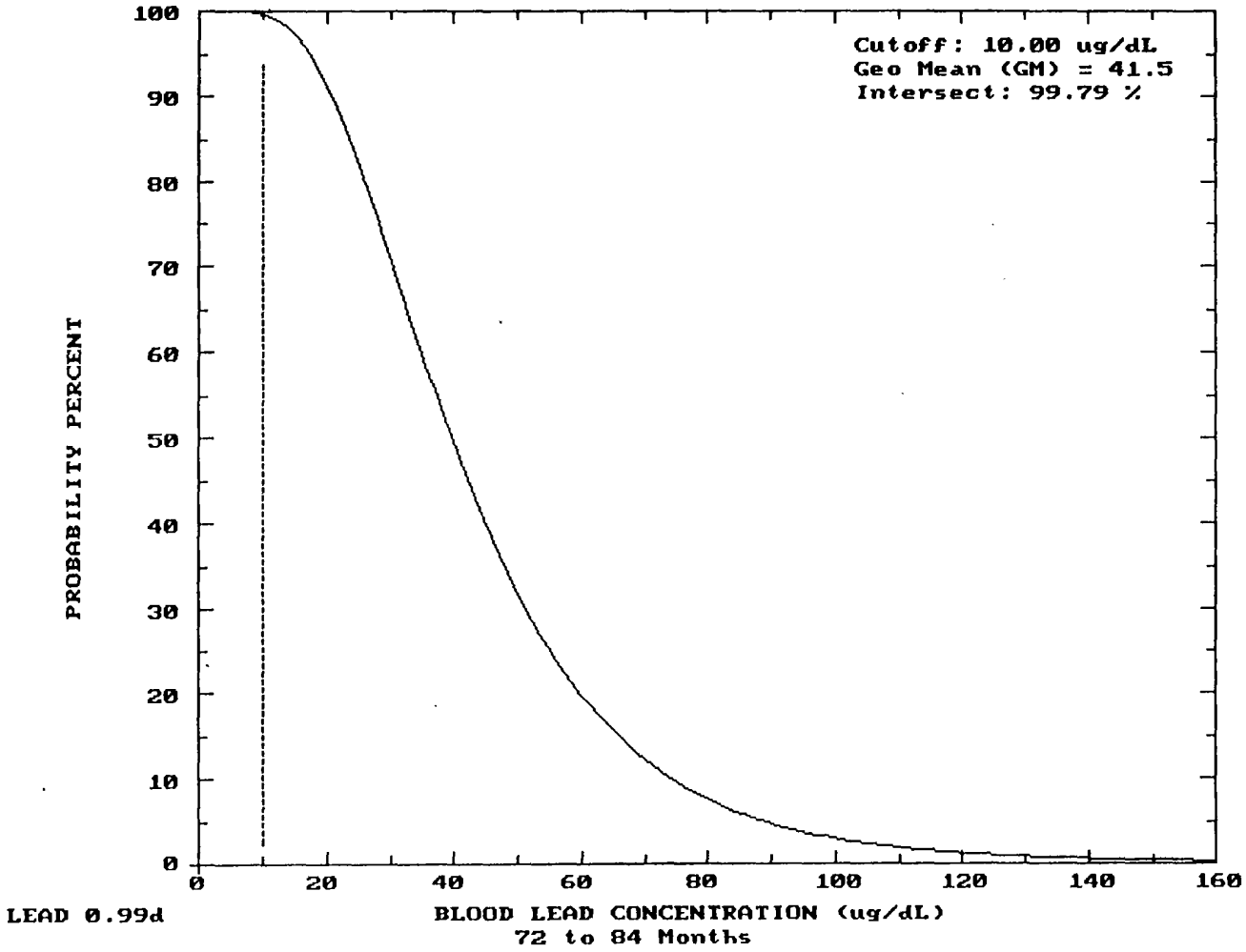
SITE - 12 (Continued)

Parameter	Default Option	User Defined Option
Drinking Water		
Lead concentration in drinking water (μg/L)	4	85.55
Ingestion rate (liters/day)		
Age =		
0-1 year (0-11 mo)	0.20	2
1-2 years (12-23 mo)	0.50	2
2-3 years (24-35 mo)	0.52	2
3-4 years (36-47 mo)	0.53	2
4-5 years (48-59 mo)	0.55	2
5-6 years (60-71 mo)	0.58	2
6-7 years (72-84 mo)	0.59	2
Soil/Dust		
Concentration		
Soil	200	55.82
Dust	200	55.82
Soil ingestion as percent of total soil and dust ingestion	45	45
Soil/Dust lead concentration (μg/g)		
Age =		
0-1 year (0-11 mo)	0.085	0.085
1-2 years (12-23 mo)	0.135	0.135
2-3 years (24-35 mo)	0.135	0.135
3-4 years (36-47 mo)	0.135	0.135
4-5 years (48-59 mo)	0.100	0.100
5-6 years (60-71 mo)	0.090	0.090
6-7 years (72-84 mo)	0.085	0.085
Dust lead concentration (μg/g)		
Age =	0.0	0.0
1-2 years (12-23 mo)	0.0	0.0
2-3 years (24-35 mo)	0.0	0.0
3-4 years (36-47 mo)	0.0	0.0
4-5 years (48-59 mo)	0.0	0.0
5-6 years (60-71 mo)	0.0	0.0
6-7 years (72-84 mo)	0.0	0.0

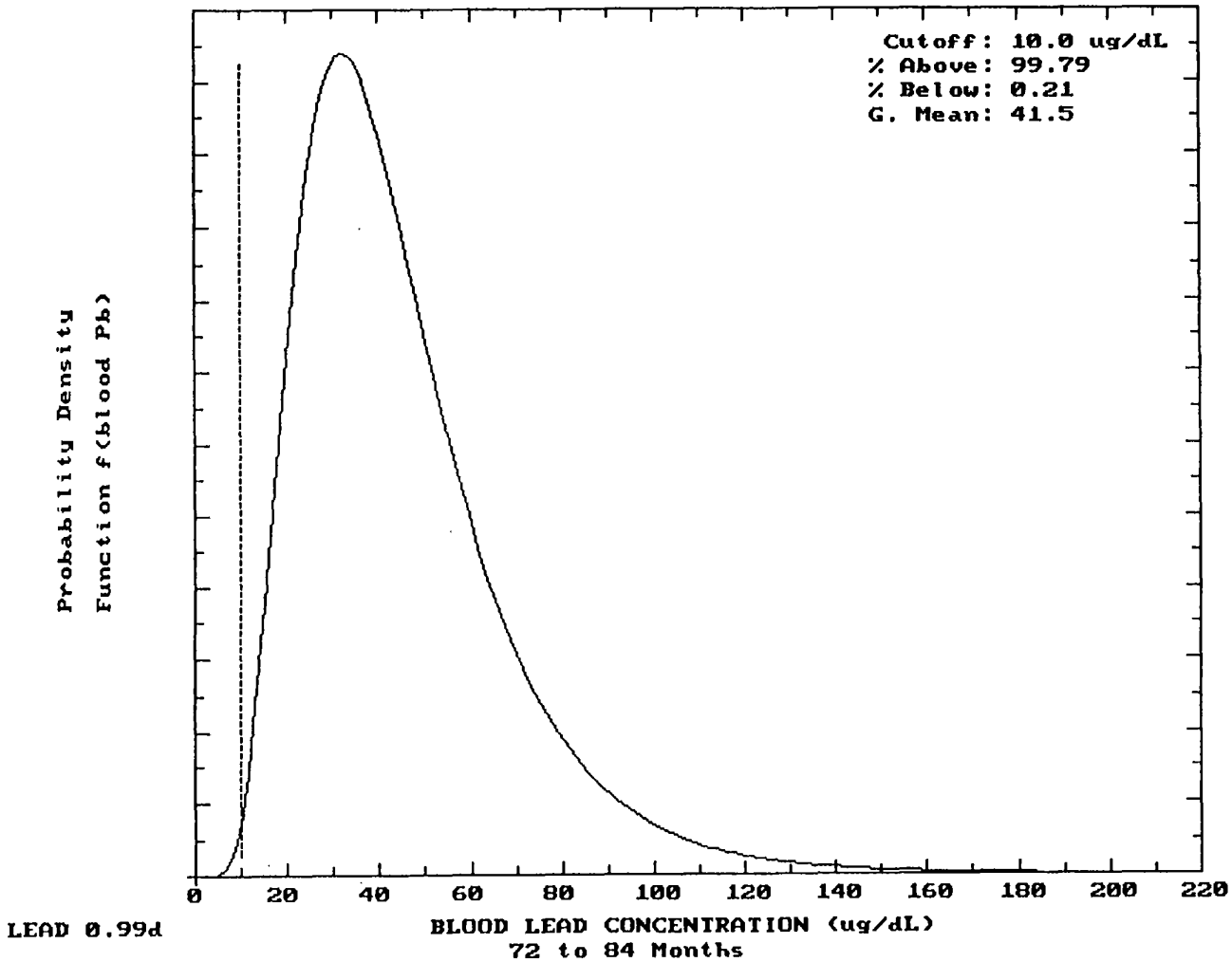
IEUBK MODEL OPTIONS

SITE - 12 (Continued)

Parameter	Default Option	User Defined Option
Bioavailability For All Gut Absorption Pathways		
Total lead Absorption (at low intake)		
diet	50	50
drinking water	50	50
soil	30	30
dust	30	30
alternate source	0	0
Fraction of lead absorbed at high intake		
diet	0.2	0.2
drinking water	0.2	0.2
soil	0.2	0.2
dust	0.2	0.2
alternate source	0.2	0.2
Maternal-to-Newborn Lead Exposure		
Mother's blood lead level at time of birth	2.5	2.5
Geometric standard deviation for blood lead (GSD)	1.6	1.6
Blood lead level of concern	10	10


Cutoff: 10.00 ug/dL
Geo Mean (GM) = 41.5
Intersect: 99.79 %
PROBABILITY PERCENT
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
BLOOD LEAD CONCENTRATION (ug/dL)
72 to 84 Months

LEAD 0.99d



Site 12
Figure N-10

SITE - 13

CONSTITUENTS DETECTED IN SURFACE SOIL SAMPLES
SITE 13
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)	Residential Soil Concentration (ug/kg) [a]	Potential Concern
VOLATILES				
Acetone	4 / 5	8 – 19	7.80E+05	NO
Toluene	3 / 5	2 – 3 j	1.60E+06	NO
SEMI–VOLATILES				
2–Methyl naphthalene	1 / 5	410 j		YES
Acenaphthene	1 / 5	950 j	4.70E+05	NO
Dibenzofuran	1 / 5	870 j		YES
Fluorene	1 / 5	1300 j	3.10E+05	NO
Pentachlorophenol	4 / 5	520 – 13000	5.30E+03	YES
Phenanthrene	4 / 5	81 – 7900		YES
Anthracene	1 / 5	1800 j	2.30E+06	NO
Fluoranthene	4 / 5	120 – 9800	3.10E+05	NO
Carbazole	1 / 5	1200 j	3.20E+04	NO
Pyrene	5 / 5	410 – 21000	2.30E+05	NO
Butylbenzyl phthalate	2 / 5	38 – 44 j	1.60E+06	NO
Benzo (a) anthracene	4 / 5	110 – 10000	8.80E+02	YES
Chrysene	4 / 5	120 – 10000	8.80E+04	NO
Bis (2) ethylhexylphthalate	3 / 5	230 – 630 j	4.60E+03	NO
Benzo (b) fluoranthene	5 / 5	140 – 13000	8.80E+02	YES
Benzo (k) fluoranthene	4 / 5	81 – 3400 j	8.80E+03	NO
Benzo (a) pyrene	4 / 5	100 – 6400	8.80E+01	YES
Indeno (1,2,3–cd)pyrene	3 / 5	200 – 4000 j	8.88E+02	YES
Dibenzo (a,h) anthracene	1 / 5	700 j	8.80E+01	NO
Benzo (g,h,i) perylene	3 / 5	190 – 3600 j		YES

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table using a target hazard quotient of 0.1 and a target cancer risk of 1e–06.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2−Methylnapthalene	4.10E−01	200	1	14	6	1E−06	15	2190	25550	2.10E−07	1.80E−08	4.00E−02	−−	5.24E−06	−−	1.10%	0.00%
Dibenzofuran	8.70E−01	200	1	14	6	1E−06	15	2190	25550	4.45E−07	3.81E−08	4.00E−03	−−	1.11E−04	−−	23.30%	0.00%
Pentachlorophenol	1.30E+01	200	1	14	6	1E−06	15	2190	25550	6.65E−06	5.70E−07	3.00E−02	1.20E−01	2.22E−04	6.84E−08	46.42%	2.28%
Phenanthrene	7.90E+00	200	1	14	6	1E−06	15	2190	25550	4.04E−06	3.46E−07	2.90E−02	−−	1.39E−04	−−	29.18%	0.00%
Benzo(a)−anthracene	1.00E+01	200	1	14	6	1E−06	15	2190	25550	5.11E−06	4.38E−07	−−	7.30E−01	−−	3.20E−07	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	200	1	14	6	1E−06	15	2190	25550	6.65E−06	5.70E−07	−−	7.30E−01	−−	4.16E−07	0.00%	13.84%
Benzo (a)−pyrene	6.40E+00	200	1	14	6	1E−06	15	2190	25550	3.27E−06	2.81E−07	−−	7.30E+00	−−	2.05E−06	0.00%	68.16%
indeno(1,2,3−cd)−pyrene	4.00E+00	200	1	14	6	1E−06	15	2190	25550	2.05E−06	1.75E−07	−−	7.30E−01	−−	1.28E−07	0.00%	4.26%
Benzo(g,h,i)−perylene	3.60E+00	200	1	14	6	1E−06	15	2190	25550	1.84E−06	1.58E−07	−−	1.55E−01	−−	2.45E−08	0.00%	0.81%
TOTAL														4.77E−04	3.00E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL – INGESTION
TRESPASSER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E-01	100	1	28	30	1E-06	70	10950	25550	4.49E-08	1.93E-08	4.00E-02	--	1.12E-06	--	1.10%	0.00%
Dibenzofuran	8.70E-01	100	1	28	30	1E-06	70	10950	25550	9.53E-08	4.09E-08	4.00E-03	--	2.38E-05	--	23.30%	0.00%
Pentachlorophenol	1.30E+01	100	1	28	30	1E-06	70	10950	25550	1.42E-06	6.11E-07	3.00E-02	1.20E-01	4.75E-05	7.33E-08	46.42%	2.28%
Phenanthrene	7.90E+00	100	1	28	30	1E-06	70	10950	25550	8.66E-07	3.71E-07	2.90E-02	--	2.99E-05	--	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	100	1	28	30	1E-06	70	10950	25550	1.10E-06	4.70E-07	--	7.30E-01	--	3.43E-07	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	100	1	28	30	1E-06	70	10950	25550	1.42E-06	6.11E-07	--	7.30E-01	--	4.46E-07	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	100	1	28	30	1E-06	70	10950	25550	7.01E-07	3.01E-07	--	7.30E+00	--	2.19E-06	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	100	1	28	30	1E-06	70	10950	25550	4.38E-07	1.88E-07	--	7.30E-01	--	1.37E-07	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	100	1	28	30	1E-06	70	10950	25550	3.95E-07	1.69E-07	--	1.55E-01	--	2.62E-08	0.00%	0.81%
TOTAL														1.02E-04	3.22E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL – INGESTION
RECREATIONAL CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E−01	67	1	14	6	1E−06	15	2190	25550	7.02E−08	6.02E−09	4.00E−02	--	1.76E−06	--	1.10%	0.00%
Dibenzofuran	8.70E−01	67	1	14	6	1E−06	15	2190	25550	1.49E−07	1.28E−08	4.00E−03	--	3.73E−05	--	23.30%	0.00%
Pentachlorophenol	1.30E+01	67	1	14	6	1E−06	15	2190	25550	2.23E−06	1.91E−07	3.00E−02	1.20E−01	7.42E−05	2.29E−08	46.42%	2.28%
Pheranthrene	7.90E+00	67	1	14	6	1E−06	15	2190	25550	1.35E−06	1.16E−07	2.90E−02	--	4.67E−05	--	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	67	1	14	6	1E−06	15	2190	25550	1.71E−06	1.47E−07	--	7.30E−01	--	1.07E−07	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	67	1	14	6	1E−06	15	2190	25550	2.23E−06	1.91E−07	--	7.30E−01	--	1.39E−07	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	67	1	14	6	1E−06	15	2190	25550	1.10E−06	9.40E−08	--	7.30E+00	--	6.86E−07	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	67	1	14	6	1E−06	15	2190	25550	6.85E−07	5.87E−08	--	7.30E−01	--	4.29E−08	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	67	1	14	6	1E−06	15	2190	25550	6.17E−07	5.29E−08	--	1.55E−01	--	8.19E−09	0.00%	0.81%
TOTAL														1.60E−04	1.01E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL – INGESTION
RECREATIONAL ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2−Methylnapthalene	4.10E−01	33	1	28	30	1E−06	70	10950	25550	1.48E−08	6.35E−09	4.00E−02	--	3.71E−07	--	1.10%	0.00%
Dibenzofuran	8.70E−01	33	1	28	30	1E−06	70	10950	25550	3.15E−08	1.35E−08	4.00E−03	--	7.87E−06	--	23.30%	0.00%
Pentachlorophenol	1.30E+01	33	1	28	30	1E−06	70	10950	25550	4.70E−07	2.01E−07	3.00E−02	1.20E−01	1.57E−05	2.42E−08	46.42%	2.28%
Phenanthrene	7.90E+00	33	1	28	30	1E−06	70	10950	25550	2.86E−07	1.22E−07	2.90E−02	--	9.85E−06	--	29.18%	0.00%
Benzo(a)−anthracene	1.00E+01	33	1	28	30	1E−06	70	10950	25550	3.62E−07	1.55E−07	--	7.30E−01	--	1.13E−07	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	33	1	28	30	1E−06	70	10950	25550	4.70E−07	2.01E−07	--	7.30E−01	--	1.47E−07	0.00%	13.84%
Benzo (a)−pyrene	6.40E+00	33	1	28	30	1E−06	70	10950	25550	2.31E−07	9.92E−08	--	7.30E+00	--	7.24E−07	0.00%	68.16%
indeno(1,2,3−cd)−pyrene	4.00E+00	33	1	28	30	1E−06	70	10950	25550	1.45E−07	6.20E−08	--	7.30E−01	--	4.53E−08	0.00%	4.26%
Benzo(g,h,i)−perylene	3.60E+00	33	1	28	30	1E−06	70	10950	25550	1.30E−07	5.58E−08	--	1.55E−01	--	8.65E−09	0.00%	0.81%
TOTAL														3.38E−05	1.06E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL – INGESTION
WORKER ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E−01	50	1	250	25	1E−06	70	9125	25550	2.01E−07	7.16E−08	4.00E−02	--	5.01E−06	--	1.10%	0.00%
Dibenzofuran	8.70E−01	50	1	250	25	1E−06	70	9125	25550	4.26E−07	1.52E−07	4.00E−03	--	1.06E−04	--	23.30%	0.00%
Pentachlorophenol	1.30E+01	50	1	250	25	1E−06	70	9125	25550	6.36E−06	2.27E−06	3.00E−02	1.20E−01	2.12E−04	2.73E−07	46.42%	2.28%
Phenanthrene	7.90E+00	50	1	250	25	1E−06	70	9125	25550	3.86E−06	1.38E−06	2.90E−02	--	1.33E−04	--	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	50	1	250	25	1E−06	70	9125	25550	4.89E−06	1.75E−06	--	7.30E−01	--	1.28E−06	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	50	1	250	25	1E−06	70	9125	25550	6.36E−06	2.27E−06	--	7.30E−01	--	1.66E−06	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	50	1	250	25	1E−06	70	9125	25550	3.13E−06	1.12E−06	--	7.30E+00	--	8.16E−06	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	50	1	250	25	1E−06	70	9125	25550	1.96E−06	6.99E−07	--	7.30E−01	--	5.10E−07	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	50	1	250	25	1E−06	70	9125	25550	1.76E−06	6.29E−07	--	1.55E−01	--	9.75E−08	0.00%	0.81%
TOTAL														4.57E−04	1.20E−05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL – DERMAL
TRESPASSER CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E-01	1820	1	0.01	14	6	1E-06	15	2190	25550	1.91E-08	1.64E-09	4.00E-02	--	4.77E-07	-	1.10%	0.00%
Dibenzofuran	8.70E-01	1820	1	0.01	14	6	1E-06	15	2190	25550	4.05E-08	3.47E-09	4.00E-03	--	1.01E-05	-	23.30%	0.00%
Pentachlorophenol	1.30E+01	1820	1	0.01	14	6	1E-06	15	2190	25550	6.05E-07	5.19E-08	3.00E-02	1.20E-01	2.02E-05	6.22E-09	46.42%	2.28%
Phenanthrene	7.90E+00	1820	1	0.01	14	6	1E-06	15	2190	25550	3.68E-07	3.15E-08	2.90E-02	--	1.27E-05	-	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	1820	1	0.01	14	6	1E-06	15	2190	25550	4.65E-07	3.99E-08	--	7.30E-01	--	2.91E-08	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	1820	1	0.01	14	6	1E-06	15	2190	25550	6.05E-07	5.19E-08	--	7.30E-01	--	3.79E-08	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	1820	1	0.01	14	6	1E-06	15	2190	25550	2.98E-07	2.55E-08	--	7.30E+00	--	1.86E-07	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	1820	1	0.01	14	6	1E-06	15	2190	25550	1.86E-07	1.60E-08	--	7.30E-01	--	1.16E-08	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	1820	1	0.01	14	6	1E-06	15	2190	25550	1.68E-07	1.44E-08	--	1.55E-01	--	2.23E-09	0.00%	0.81%
TOTAL															4.34E-05	2.73E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL – DERMAL
TRESPASSER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E−01	5800	1	0.01	28	30	1E−06	70	10950	25550	2.61E−08	1.12E−08	4.00E−02	--	6.52E−07	–	1.10%	0.00%
Dibenzofuran	8.70E−01	5800	1	0.01	28	30	1E−06	70	10950	25550	5.53E−08	2.37E−08	4.00E−03	--	1.38E−05	–	23.30%	0.00%
Pentachlorophenol	1.30E+01	5800	1	0.01	28	30	1E−06	70	10950	25550	8.26E−07	3.54E−07	3.00E−02	1.20E−01	2.75E−05	4.25E−08	46.42%	2.28%
Phenanthrene	7.90E+00	5800	1	0.01	28	30	1E−06	70	10950	25550	5.02E−07	2.15E−07	2.90E−02	--	1.73E−05	–	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	5800	1	0.01	28	30	1E−06	70	10950	25550	6.36E−07	2.72E−07	--	7.30E−01	--	1.99E−07	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	5800	1	0.01	28	30	1E−06	70	10950	25550	8.26E−07	3.54E−07	--	7.30E−01	--	2.59E−07	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	5800	1	0.01	28	30	1E−06	70	10950	25550	4.07E−07	1.74E−07	--	7.30E+00	--	1.27E−06	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	5800	1	0.01	28	30	1E−06	70	10950	25550	2.54E−07	1.09E−07	--	7.30E−01	--	7.95E−08	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	5800	1	0.01	28	30	1E−06	70	10950	25550	2.29E−07	9.81E−08	--	1.55E−01	--	1.52E−08	0.00%	0.81%
TOTAL															5.93E−05	1.87E−06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL -- DERMAL
RECREATIONAL CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E-01	1820	1	0.01	14	6	1E-06	15	2190	25550	1.91E-08	1.64E-09	4.00E-02	--	4.77E-07	-	1.10%	0.00%
Dibenzofuran	8.70E-01	1820	1	0.01	14	6	1E-06	15	2190	25550	4.05E-08	3.47E-09	4.00E-03	--	1.01E-05	-	23.30%	0.00%
Pentachlorophenol	1.30E+01	1820	1	0.01	14	6	1E-06	15	2190	25550	6.05E-07	5.19E-08	3.00E-02	1.20E-01	2.02E-05	6.22E-09	46.42%	2.28%
Phenanthrene	7.90E+00	1820	1	0.01	14	6	1E-06	15	2190	25550	3.68E-07	3.15E-08	2.90E-02	--	1.27E-05	-	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	1820	1	0.01	14	6	1E-06	15	2190	25550	4.65E-07	3.99E-08	--	7.30E-01	--	2.91E-08	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	1820	1	0.01	14	6	1E-06	15	2190	25550	6.05E-07	5.19E-08	--	7.30E-01	--	3.79E-08	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	1820	1	0.01	14	6	1E-06	15	2190	25550	2.98E-07	2.55E-08	--	7.30E+00	--	1.86E-07	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	1820	1	0.01	14	6	1E-06	15	2190	25550	1.86E-07	1.60E-08	--	7.30E-01	--	1.16E-08	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	1820	1	0.01	14	6	1E-06	15	2190	25550	1.68E-07	1.44E-08	--	1.55E-01	--	2.23E-09	0.00%	0.81%
TOTAL															4.34E-05	2.73E-07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL – DERMAL
RECREATIONAL ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E-01	5800	1	0.01	28	30	1E-06	70	10950	25550	2.61E-08	1.12E-08	4.00E-02	--	6.52E-07	–	1.10%	0.00%
Dibenzofuran	8.70E-01	5800	1	0.01	28	30	1E-06	70	10950	25550	5.53E-08	2.37E-08	4.00E-03	--	1.38E-05	–	23.30%	0.00%
Pentachlorophenol	1.30E+01	5800	1	0.01	28	30	1E-06	70	10950	25550	8.26E-07	3.54E-07	3.00E-02	1.20E-01	2.75E-05	4.25E-08	46.42%	2.28%
Phenanthrene	7.90E+00	5800	1	0.01	28	30	1E-06	70	10950	25550	5.02E-07	2.15E-07	2.90E-02	--	1.73E-05	–	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	5800	1	0.01	28	30	1E-06	70	10950	25550	6.36E-07	2.72E-07	--	7.30E-01	--	1.99E-07	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	5800	1	0.01	28	30	1E-06	70	10950	25550	8.26E-07	3.54E-07	--	7.30E-01	--	2.59E-07	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	5800	1	0.01	28	30	1E-06	70	10950	25550	4.07E-07	1.74E-07	--	7.30E+00	--	1.27E-06	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	5800	1	0.01	28	30	1E-06	70	10950	25550	2.54E-07	1.09E-07	--	7.30E-01	--	7.95E-08	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	5800	1	0.01	28	30	1E-06	70	10950	25550	2.29E-07	9.81E-08	--	1.55E-01	--	1.52E-08	0.00%	0.81%
TOTAL															5.93E-05	1.87E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 13

CURRENT SCENARIO
SOIL – DERMAL
WORKER ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E-01	5800	1	0.01	250	25	1E-06	70	9125	25550	2.33E-07	8.31E-08	4.00E-02	--	5.82E-06	-	1.10%	0.00%
Dibenzofuran	8.70E-01	5800	1	0.01	250	25	1E-06	70	9125	25550	4.94E-07	1.76E-07	4.00E-03	--	1.23E-04	-	23.30%	0.00%
Pentachlorophenol	1.30E+01	5800	1	0.01	250	25	1E-06	70	9125	25550	7.38E-06	2.63E-06	3.00E-02	1.20E-01	2.46E-04	3.16E-07	46.42%	2.28%
Phenanthrene	7.90E+00	5800	1	0.01	250	25	1E-06	70	9125	25550	4.48E-06	1.60E-06	2.90E-02	--	1.55E-04	-	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	5800	1	0.01	250	25	1E-06	70	9125	25550	5.68E-06	2.03E-06	--	7.30E-01	--	1.48E-06	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	5800	1	0.01	250	25	1E-06	70	9125	25550	7.38E-06	2.63E-06	--	7.30E-01	--	1.92E-06	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	5800	1	0.01	250	25	1E-06	70	9125	25550	3.63E-06	1.30E-06	--	7.30E+00	--	9.47E-06	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	5800	1	0.01	250	25	1E-06	70	9125	25550	2.27E-06	8.11E-07	--	7.30E-01	--	5.92E-07	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	5800	1	0.01	250	25	1E-06	70	9125	25550	2.04E-06	7.30E-07	--	1.55E-01	--	1.13E-07	0.00%	0.81%
TOTAL															5.30E-04	1.39E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 13

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E-01	200	1	350	6	1E-06	15	2190	25550	5.24E-06	4.49E-07	4.00E-02	--	1.31E-04	--	1.10%	0.00%
Dibenzofuran	8.70E-01	200	1	350	6	1E-06	15	2190	25550	1.11E-05	9.53E-07	4.00E-03	--	2.78E-03	--	23.30%	0.00%
Pentachlorophenol	1.30E+01	200	1	350	6	1E-06	15	2190	25550	1.66E-04	1.42E-05	3.00E-02	1.20E-01	5.54E-03	1.71E-06	46.42%	2.28%
Phenanthrene	7.90E+00	200	1	350	6	1E-06	15	2190	25550	1.01E-04	8.66E-06	2.90E-02	--	3.48E-03	--	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	200	1	350	6	1E-06	15	2190	25550	1.28E-04	1.10E-05	--	7.30E-01	--	8.00E-06	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	200	1	350	6	1E-06	15	2190	25550	1.66E-04	1.42E-05	--	7.30E-01	--	1.04E-05	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	200	1	350	6	1E-06	15	2190	25550	8.18E-05	7.01E-06	--	7.30E+00	--	5.12E-05	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	200	1	350	6	1E-06	15	2190	25550	5.11E-05	4.38E-06	--	7.30E-01	--	3.20E-06	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	200	1	350	6	1E-06	15	2190	25550	4.60E-05	3.95E-06	--	1.55E-01	--	6.12E-07	0.00%	0.81%
TOTAL														1.19E-02	7.51E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SURFACE SOIL
SITE 13

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E−01	100	1	350	30	1E−06	70	10950	25550	5.62E−07	2.41E−07	4.00E−02	--	1.40E−05	--	1.10%	0.00%
Dibenzofuran	8.70E−01	100	1	350	30	1E−06	70	10950	25550	1.19E−06	5.11E−07	4.00E−03	--	2.98E−04	--	23.30%	0.00%
Pentachlorophenol	1.30E+01	100	1	350	30	1E−06	70	10950	25550	1.78E−05	7.63E−06	3.00E−02	1.20E−01	5.94E−04	9.16E−07	46.42%	2.28%
Phenanthrene	7.90E+00	100	1	350	30	1E−06	70	10950	25550	1.08E−05	4.64E−06	2.90E−02	--	3.73E−04	--	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	100	1	350	30	1E−06	70	10950	25550	1.37E−05	5.87E−06	--	7.30E−01	--	4.29E−06	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	100	1	350	30	1E−06	70	10950	25550	1.78E−05	7.63E−06	--	7.30E−01	--	5.57E−06	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	100	1	350	30	1E−06	70	10950	25550	8.77E−06	3.76E−06	--	7.30E+00	--	2.74E−05	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	100	1	350	30	1E−06	70	10950	25550	5.48E−06	2.35E−06	--	7.30E−01	--	1.71E−06	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	100	1	350	30	1E−06	70	10950	25550	4.93E−06	2.11E−06	--	1.55E−01	--	3.28E−07	0.00%	0.81%
TOTAL														1.28E−03	4.02E−05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 13

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E-01	1820	1	0.01	350	6	1E-06	15	2190	25550	4.77E-07	4.09E-08	4.00E-02	--	1.19E-05	-	1.10%	0.00%
Dibenzofuran	8.70E-01	1820	1	0.01	350	6	1E-06	15	2190	25550	1.01E-06	8.68E-08	4.00E-03	--	2.53E-04	-	23.30%	0.00%
Pentachlorophenol	1.30E+01	1820	1	0.01	350	6	1E-06	15	2190	25550	1.51E-05	1.30E-06	3.00E-02	1.20E-01	5.04E-04	1.56E-07	46.42%	2.28%
Phenanthrene	7.90E+00	1820	1	0.01	350	6	1E-06	15	2190	25550	9.19E-06	7.88E-07	2.90E-02	--	3.17E-04	-	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	1820	1	0.01	350	6	1E-06	15	2190	25550	1.16E-05	9.97E-07	--	7.30E-01	--	7.28E-07	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	1820	1	0.01	350	6	1E-06	15	2190	25550	1.51E-05	1.30E-06	--	7.30E-01	--	9.46E-07	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	1820	1	0.01	350	6	1E-06	15	2190	25550	7.45E-06	6.38E-07	--	7.30E+00	--	4.66E-06	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	1820	1	0.01	350	6	1E-06	15	2190	25550	4.65E-06	3.99E-07	--	7.30E-01	--	2.91E-07	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	1820	1	0.01	350	6	1E-06	15	2190	25550	4.19E-06	3.59E-07	--	1.55E-01	--	5.56E-08	0.00%	0.81%
TOTAL															1.09E-03	6.84E-06	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SURFACE SOIL
SITE 13

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
2-Methylnapthalene	4.10E-01	5800	1	0.01	350	30	1E-06	70	10950	25550	3.26E-07	1.40E-07	4.00E-02	--	8.14E-06	-	1.10%	0.00%
Dibenzofuran	8.70E-01	5800	1	0.01	350	30	1E-06	70	10950	25550	6.91E-07	2.96E-07	4.00E-03	--	1.73E-04	-	23.30%	0.00%
Pentachlorophenol	1.30E+01	5800	1	0.01	350	30	1E-06	70	10950	25550	1.03E-05	4.43E-06	3.00E-02	1.20E-01	3.44E-04	5.31E-07	46.42%	2.28%
Phenanthrene	7.90E+00	5800	1	0.01	350	30	1E-06	70	10950	25550	6.28E-06	2.69E-06	2.90E-02	--	2.16E-04	-	29.18%	0.00%
Benzo(a)-anthracene	1.00E+01	5800	1	0.01	350	30	1E-06	70	10950	25550	7.95E-06	3.41E-06	--	7.30E-01	--	2.49E-06	0.00%	10.65%
Benzo(b)fluoranthtene	1.30E+01	5800	1	0.01	350	30	1E-06	70	10950	25550	1.03E-05	4.43E-06	--	7.30E-01	--	3.23E-06	0.00%	13.84%
Benzo (a)-pyrene	6.40E+00	5800	1	0.01	350	30	1E-06	70	10950	25550	5.08E-06	2.18E-06	--	7.30E+00	--	1.59E-05	0.00%	68.16%
indeno(1,2,3-cd)-pyrene	4.00E+00	5800	1	0.01	350	30	1E-06	70	10950	25550	3.18E-06	1.36E-06	--	7.30E-01	--	9.94E-07	0.00%	4.26%
Benzo(g,h,i)-perylene	3.60E+00	5800	1	0.01	350	30	1E-06	70	10950	25550	2.86E-06	1.23E-06	--	1.55E-01	--	1.90E-07	0.00%	0.81%
TOTAL															7.42E-04	2.33E-05	100.00%	100.00%

CONSTITUENTS DETECTED IN SUBSURFACE SOIL SAMPLES
SITE 13
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)	Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Water Stds. (ug/l) [d]	Potential Concern
VOLATILES							
Acetone	1 / 3	130 j		370			NO
Ethylbenzene	1 / 3	17 j	3100	130	700	3100	NO
Xylene	2 / 3	120 – 190		1200	10000		NO
SEMI-VOLATILES							
Naphthalene	1 / 3	85 j		150			NO
2-Methylnaphthalene	2 / 3	120 – 6300					YES
Pentachlorophenol	3 / 3	30000 – 890000	0.28	0.56	1		YES
Bis (2) ethylhexphthalate	1 / 3	55 j	1.8	4.8			NO

Notes:

a. MCL concentration values represent US Federal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk-Based Concentration Table using a target hazard quotient of 0.1, and a target cancer risk of 1e-06.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Water Standards for public water supplies.

CONSTITUENTS DETECTED IN SUBSURFACE SOIL SAMPLES
SITE 13
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/kg)	Residential Soil Concentration (ug/kg) [a]	Potential Concern
VOLATILES				
Acetone	1 / 3	130 j	7.80E+05	NO
Ethylbenzene	1 / 3	17 j	7.80E+05	NO
Xylene	2 / 3	120 – 190	1.60E+07	NO
SEMI-VOLATILES				
Naphthalene	1 / 3	85 j		YES
2-Methylnaphthalene	2 / 3	120 – 6300		YES
Pentachlorophenol	3 / 3	30000 – 890000	5.30E+03	YES
Bis (2) ethylhexphthalate	1 / 3	55 J	4.60E+04	NO

Notes:

a. Residential Soil Concentration values obtained from July 11, 1994 USEPA Region III Risk-Based Concentration Table using a target hazard quotient of 0.1, and a target cancer risk of 1e-06.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SUBSURFACE SOIL
SITE 13

FUTURE SCENARIO
SOIL – INGESTION
RESIDENT CHILD

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Naphthalene	8.50E−02	200	1	350	6	1E−06	15	2190	25550	1.09E−06	9.32E−08	1.00E−01	--	1.09E−05	--	0.00%	0.00%
2−Methylnapthalene	6.30E+00	200	1	350	6	1E−06	15	2190	25550	8.05E−05	6.90E−06	4.00E−02	--	2.01E−03	--	0.53%	0.00%
Pentachlorophenol	8.90E+02	200	1	350	6	1E−06	15	2190	25550	1.14E−02	9.75E−04	3.00E−02	1.20E−01	3.79E−01	1.17E−04	99.47%	100.00%
TOTAL														3.81E−01	1.17E−04	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF SUBSURFACE SOIL
SITE 13

FUTURE SCENARIO
SOIL -- INGESTION
RESIDENT ADULT

CHEMICAL	CS mg/kg	IR mg/d	FI	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Naphthalene	8.50E-02	100	1	350	30	1E-06	70	10950	25550	1.16E-07	4.99E-08	1.00E-01	--	1.16E-06	--	0.00%	0.00%
2-Methylnapthalene	6.30E+00	100	1	350	30	1E-06	70	10950	25550	8.63E-06	3.70E-06	4.00E-02	--	2.16E-04	--	0.53%	0.00%
Pentachlorophenol	8.90E+02	100	1	350	30	1E-06	70	10950	25550	1.22E-03	5.23E-04	3.00E-02	1.20E-01	4.06E-02	6.27E-05	99.47%	100.00%
TOTAL														4.09E-02	6.27E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SUBSURFACE SOIL
SITE 13

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT CHILD

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Naphthalene	8.50E-02	1820	1	0.01	350	6	1E-06	15	2190	25550	9.89E-08	8.48E-09	1.00E-01	--	9.89E-07	-	0.00%	0.00%
2-Methylnapthalene	6.30E+00	1820	1	0.01	350	6	1E-06	15	2190	25550	7.33E-06	6.28E-07	4.00E-02	--	1.83E-04	-	0.53%	0.00%
Pentachlorophenol	8.90E+02	1820	1	0.01	350	6	1E-06	15	2190	25550	1.04E-03	8.88E-05	3.00E-02	1.20E-01	3.45E-02	1.07E-05	99.47%	100.00%
TOTAL															3.47E-02	1.07E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH SUBSURFACE SOIL
SITE 13

FUTURE SCENARIO
SOIL – DERMAL
RESIDENT ADULT

CHEMICAL	CS mg/kg	SA cm^2	AF mg/cm^2	ABS	EF d/y	ED y	CF kg/mg	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Naphthalene	8.50E-02	5800	1	0.01	350	30	1E-06	70	10950	25550	6.75E-08	2.89E-08	1.00E-01	--	6.75E-07	-	0.00%	0.00%
2-Methylnapthalene	6.30E+00	5800	1	0.01	350	30	1E-06	70	10950	25550	5.01E-06	2.15E-06	4.00E-02	--	1.25E-04	-	0.53%	0.00%
Pentachlorophenol	8.90E+02	5800	1	0.01	350	30	1E-06	70	10950	25550	7.07E-04	3.03E-04	3.00E-02	1.20E-01	2.36E-02	3.64E-05	99.47%	100.00%
TOTAL															2.37E-02	3.64E-05	100.00%	100.00%

CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
SITE 13
NAVAL AMPHIBIOUS BASE – LITTLE CREEK
VIRGINIA BEACH, VIRGINIA

Constituent	Frequency of Detection	Range of Detected Concentrations (ug/l)	Federal MCL (ug/l) [a]	Tap Water (ug/l) [b]	Health Advisory (ug/l) [c]	Virginia Ground Water Stds. (ug/l) [d]	Potential Concern
VOLATILES							
Vinyl chloride	2 / 6	4 j – 200.0	2	0.019	2		YES
Carbon Disulfide	1 / 6	2 j		2.1			NO
1,1–Dichloroethane	1 / 6	7 j		81			NO
1,2–Dichloroethene (total)	1 / 6	5 j		5.5	70		NO
Trichloroethene	4 / 6	1 j – 5 j	2.7	1.6	5		YES
Tetrachloroethene	2 / 6	2 j – 7 j	0.8	1.1	5		YES
1,1,2,2–Tetrachloroethane	1 / 6	55	0.17	0.052			YES
Toluene	1 / 6	2 j	6800	75	1000		NO
Chlorobenzene	2 / 6	3 j – 110	680	3.9			YES
Ethylbenzene	2 / 6	6 j – 15	3100	130	700		NO
Xylene	2 / 6	5 j – 77		1200	10000		NO
SEMIVOLATILES							
1,4–Dichlorobenzene	1 / 6	1 j	400	0.44	75		NO
Naphthalene	2 / 6	3 j – 96 j		150			NO
2–Methylnaphthalene	1 / 6	170 j					NO
Acenaphthene	1 / 6	1 j		220			NO
Dibenzofuran	1 / 6	2 j					NO
Fluorene	1 / 6	1 j	1300	150			NO
Pentachlorophenol	3 / 6	20 j – 1700	0.28	0.56	1		YES

Notes:

a. Federal MCL concentration values represent US Federal Maximum Contaminant Level for potable water supplies.

b. Tap Water Concentration values obtained from July 11, 1994 USEPA Region III Risk–Based Concentration Table using a target hazard quotient of 0.1.

c. Health Advisory Concentration values obtained from December 1993 USEPA Office of Water publication "Drinking Water Regulations and Health Advisories."

d. Virginia Groundwater Standards Applicable Statewide.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 13

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Vinyl Chloride	2.00E+02	1	14	6	1E−03	15	2190	25550	5.11E−04	4.38E−05	--	1.90E+00	--	8.33E−05	0.00%	63.82%
Trichloroethene	5.00E+00	1	14	6	1E−03	15	2190	25550	1.28E−05	1.10E−06	6.00E−03	1.10E−02	2.13E−03	1.21E−08	1.31%	0.01%
Tetrachloroethene	7.00E+00	1	14	6	1E−03	15	2190	25550	1.79E−05	1.53E−06	1.00E−02	5.20E−02	1.79E−03	7.98E−08	1.10%	0.06%
1,1,2,2−Tetrachloroethane	5.50E+01	1	14	6	1E−03	15	2190	25550	1.41E−04	1.21E−05	--	2.00E−01	--	2.41E−06	0.00%	1.85%
Chlorobenzene	1.10E+02	1	14	6	1E−03	15	2190	25550	2.81E−04	2.41E−05	2.00E−02	--	1.41E−02	--	8.63%	0.00%
Pentachlorophenol	1.70E+03	1	14	6	1E−03	15	2190	25550	4.35E−03	3.73E−04	3.00E−02	1.20E−01	1.45E−01	4.47E−05	88.96%	34.26%
TOTAL													1.63E−01	1.31E−04	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INGESTION OF GROUNDWATER
SITE 13

FUTURE SCENARIO
GROUNDWATER – INGESTION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	CR L/d	EF d/y	ED y	CF mg/ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)−1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Vinyl Chloride	2.00E+02	2	28	30	1E−06	70	10950	25550	4.38E−07	1.88E−07	--	1.90E+00	--	3.57E−07	0.00%	63.82%
Trichloroethene	5.00E+00	2	28	30	1E−06	70	10950	25550	1.10E−08	4.70E−09	6.00E−03	1.10E−02	1.83E−06	5.17E−11	1.31%	0.01%
Tetrachloroethene	7.00E+00	2	28	30	1E−06	70	10950	25550	1.53E−08	6.58E−09	1.00E−02	5.20E−02	1.53E−06	3.42E−10	1.10%	0.06%
1,1,2,2−Tetrachloroethane	5.50E+01	2	28	30	1E−06	70	10950	25550	1.21E−07	5.17E−08	--	2.00E−01	--	1.03E−08	0.00%	1.85%
Chlorobenzene	1.10E+02	2	28	30	1E−06	70	10950	25550	2.41E−07	1.03E−07	2.00E−02	--	1.21E−05	--	8.63%	0.00%
Pentachlorophenol	1.70E+03	2	28	30	1E−06	70	10950	25550	3.73E−06	1.60E−06	3.00E−02	1.20E−01	1.24E−04	1.92E−07	88.96%	34.26%
TOTAL													1.40E−04	5.59E−07	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 13

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Vinyl Chloride	2.00E+02	7280	0.0073 *	0.2	14	6	1E-06	15	2190	25550	2.72E-05	2.33E-06	--	1.90E+00	--	4.43E-06	0.00%	2.05%
Trichloroethene	5.00E+00	7280	0.23 **	0.2	14	6	1E-06	15	2190	25550	2.14E-05	1.83E-06	6.00E-03	1.10E-02	3.57E-03	2.02E-08	0.51%	0.01%
Tetrachloroethene	7.00E+00	7280	0.37 **	0.2	14	6	1E-06	15	2190	25550	4.82E-05	4.13E-06	1.00E-02	5.20E-02	4.82E-03	2.15E-07	0.69%	0.10%
1,1,2,2-Tetrachloroethane	5.50E+01	7280	0.009 *	0.2	14	6	1E-06	15	2190	25550	9.21E-06	7.90E-07	--	2.00E-01	--	1.58E-07	0.00%	0.07%
Chlorobenzene	1.10E+02	7280	0.041 *	0.2	14	6	1E-06	15	2190	25550	8.40E-05	7.20E-06	2.00E-02	--	4.20E-03	-	0.60%	0.00%
Pentachlorophenol	1.70E+03	7280	0.65 *	0.2	14	6	1E-06	15	2190	25550	2.06E-02	1.76E-03	3.00E-02	1.20E-01	6.86E-01	2.12E-04	98.20%	97.77%
TOTAL															6.98E-01	2.16E-04	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Chemical specific dermal permeability constant (PC) not available. Used water PC, USEPA, 1992.

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM DERMAL CONTACT WITH GROUNDWATER
SITE 13

FUTURE SCENARIO
GROUNDWATER – DERMAL
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/L	SA cm^2	PC cm/hr	ET hr/d	EF d/y	ED y	CF L mg/cm^3 ug	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfD mg/kg/d	CSF (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Vinyl Chloride	2.00E+02	23000	0.0073 *	0.2	28	30	1E-06	70	10950	25550	3.68E-05	1.58E-05	--	1.90E+00	--	3.00E-05	0.00%	2.05%
Trichloroethene	5.00E+00	23000	0.23 **	0.2	28	30	1E-06	70	10950	25550	2.90E-05	1.24E-05	6.00E-03	1.10E-02	4.83E-03	1.37E-07	0.51%	0.01%
Tetrachloroethene	7.00E+00	23000	0.37 **	0.2	28	30	1E-06	70	10950	25550	6.53E-05	2.80E-05	1.00E-02	5.20E-02	6.53E-03	1.45E-06	0.69%	0.10%
1,1,2,2-Tetrachloroethane	5.50E+01	23000	0.009 *	0.2	28	30	1E-06	70	10950	25550	1.25E-05	5.35E-06	--	2.00E-01	--	1.07E-06	0.00%	0.07%
Chlorobenzene	1.10E+02	23000	0.041 *	0.2	28	30	1E-06	70	10950	25550	1.14E-04	4.87E-05	2.00E-02	--	5.68E-03	-	0.60%	0.00%
Pentachlorophenol	1.70E+03	23000	0.65 *	0.2	28	30	1E-06	70	10950	25550	2.79E-02	1.19E-02	3.00E-02	1.20E-01	9.28E-01	1.43E-03	98.20%	97.77%
TOTAL															9.45E-01	1.47E-03	100.00%	100.00%

* Chemical specific dermal permeability constant–estimated value, USEPA, 1992
** Chemical specific dermal permeability constant–measured, USEPA, 1992
*** Chemical specific dermal permeability constant–default value, USEPA, 1992
**** Not available chemical specific dermal permeability constant (PC). Used PC of water, USEPA 1988

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INHALATION OF GROUNDWATER
SITE 13

FUTURE SCENARIO
GROUNDWATER – INHALATION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) CHILD

CHEMICAL	CW ug/l	CF mg/ug	WV L	RV m3	IR m3/d	EF d/yr	ED yr	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfDi mg/kg/d	CSFi (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Vinyl Chloride	2.00E+02	1.0E-03	2.0E+02	12	0.12	14	9	15	3285	25550	1.02E-03	1.32E-04	--	3.00E-01	0.00E+00	3.95E-05	0.00%	84.26%
Trichloroethene	5.00E+00	1.0E-03	2.0E+02	12	0.12	14	9	15	3285	25550	2.56E-05	3.29E-06	--	6.00E-03	0.00E+00	1.97E-08	0.00%	0.04%
Tetrachloroethene	7.00E+00	1.0E-03	2.0E+02	12	0.12	14	9	15	3285	25550	3.58E-05	4.60E-06	--	2.03E-03	0.00E+00	9.34E-09	0.00%	0.02%
1,1,2,2-Tetrachloroethane	5.50E+01	1.0E-03	2.0E+02	12	0.12	14	9	15	3285	25550	2.81E-04	3.62E-05	--	2.03E-01	0.00E+00	7.34E-06	0.00%	15.68%
Chlorobenzene	1.10E+02	1.0E-03	2.0E+02	12	0.12	14	9	15	3285	25550	5.63E-04	7.23E-05	5.71E-03	--	9.85E-02	0.00E+00	100.00%	0.00%
Pentachlorophenol	1.70E+03	1.0E-03	2.0E+02	12	0.12	14	9	15	3285	25550	8.69E-03	1.12E-03	--	--	0.00E+00	0.00E+00	0.00%	0.00%
TOTAL															9.85E-02	4.68E-05	100.00%	100.00%

SUMMARY OF CHRONIC DAILY INTAKE (CDI) AND POTENTIAL NONCARCINOGENIC
AND CARCINOGENIC RISK FROM INHALATION OF GROUNDWATER
SITE 13

FUTURE SCENARIO
GROUNDWATER -- INHALATION
RESIDENT (EXPOSED AS TRESPASSER/RECREATIONAL) ADULT

CHEMICAL	CW ug/l	CF mg/ug	WV l	RV m3	IR m3/d	EF d/yr	ED yr	BW kg	ATnc d	ATc d	CDInc mg/kg/d	CDIc mg/kg/d	RfDi mg/kg/d	CSFi (mg/kg/d)-1	HI	CR	% CONTRIB NC RISK	% CONTRIB CARC RISK
Vinyl Chloride	2.00E+02	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	4.38E-04	1.88E-04	--	3.00E-01	0.00E+00	5.64E-05	0.00%	84.26%
Trichloroethene	5.00E+00	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	1.10E-05	4.70E-06	--	6.00E-03	0.00E+00	2.82E-08	0.00%	0.04%
Tetrachloroethene	7.00E+00	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	1.53E-05	6.58E-06	--	2.03E-03	0.00E+00	1.33E-08	0.00%	0.02%
1,1,2,2-Tetrachloroethane	5.50E+01	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	1.21E-04	5.17E-05	--	2.03E-01	0.00E+00	1.05E-05	0.00%	15.68%
Chlorobenzene	1.10E+02	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	2.41E-04	1.03E-04	5.71E-03	--	4.22E-02	0.00E+00	100.00%	0.00%
Pentachlorophenol	1.70E+03	1.0E-03	2.0E+02	12	0.12	28	30	70	10950	25550	3.73E-03	1.60E-03	--	--	0.00E+00	0.00E+00	0.00%	0.00%
TOTAL															4.22E-02	6.69E-05	100.00%	100.00%

APPENDIX O

Applicable Remedial Technologies

APPENDIX O : APPLICABLE REMEDIAL TECHNOLOGIES

This appendix presents the specific remedial technologies associated with the general response actions listed in Section 8.5. The discussion of these remedial technologies associated with a typical cleanup of contaminated soil and water media were developed from: the Interim Final Guidance for Conducting RI/FS under CERCLA (October 1988); the Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites (December 1988); the revised Handbook for Remedial Action at Waste Disposal Sites (1985); experience on other hazardous waste projects; knowledge of new technologies; and the best professional judgement of FWES engineers and scientists performing feasibility studies.

O.1: No Further Action

The No Further Action alternative is developed and evaluated to establish a baseline for comparison with other remedial alternatives for NAB Little Creek sites. CERCLA mandates a five-year review to be conducted to determine whether or not the contamination has spread. If necessary, appropriate action would be considered at that time.

O.2: Institutional Controls

Institutional control options include access restrictions, deed restrictions, and public education programs.

Access Restrictions: Fencing is one of the option to restrict direct access to the site. Most of the sites at NAB Little Creek are not fenced. Fencing is not viable at sites 11, 12, 13 which are operating facilities rather than landfills. Another form of access restriction is posting warning signs against the unauthorized access. This can eliminate the risk pathways associated with ingestion or dermal contact by a child or an adult casually wandering in. Fencing would not reduce any toxicity, mobility, or volume; and it won't be effective in reducing exposure to groundwater contamination either.

Deed Restrictions: Probable deed restrictions include prohibiting excavation or any other intrusive activities at the site. In order to reduce exposure to groundwater, installing new wells screened in the water table aquifer can be prohibited. A more severe measure would be prohibiting the use of existing wells within a certain distance from the site.

Public Education Programs: As part of the community involvement effort, area residents would be appraised of the potential risks and their magnitude.

O.3: Groundwater Containment Technologies

Slurry Walls: Subsurface barriers such as sheet piling cut-off walls or slurry walls constructed of low permeability material have been used on many sites to control groundwater movement. Vertical barriers control groundwater by restricting movement across the barrier. The slurry wall is constructed by backfilling an excavated trench with bentonite slurry. Sheet piling cut-off walls consist of interlocking metal sheets, which may be plastic-coated to prevent galvanic corrosion, that are driven into the ground using a pile driver or similar device. Construction of slurry walls is technically feasible unless the depth becomes excessive. Cost of this option depend on the area which needs to be covered and the depth.

Slurry walls do not reduce the toxicity or volume of contaminated groundwater. They are effective in controlling

contaminated groundwater mobility if the bottom of the slurry wall intersects a natural zone of low permeability, i.e. a confining clay layer. At NAB Little Creek sites, almost the entire area has a clay layer underneath the fill material and sand layer. This clay layer is encountered 20 feet bgs on an average and no more than 40 feet bgs. Therefore, slurry walls can be a potential containment measure, keyed into the clay layer.

Slurry walls are also used at some sites to reduce groundwater flow through the source and subsequent leaching of contaminants into the groundwater. At NAB Little Creek sites, these consideration do not apply.

Other measures: Extraction wells are used as a containment measure, a discussion of which is presented under the collection technologies. Caps of various type present another groundwater containment option by preventing infiltration, their discussion follows under soil containment technologies.

O.4: Groundwater Collection Technologies

Groundwater collection technologies involve the active manipulation (pumping) and management of groundwater prior to subsequent treatment and/or disposal. Collection technologies are utilized to remove the contaminated groundwater from the aquifer and to physically prevent or reduce plume migration. The selection of an appropriate groundwater collection system depends upon the objectives of the remedial action, the depth of contamination, and the geologic and hydrogeologic characteristics of the aquifer.

Barrier Drain Systems: The barrier drain system uses trench drains, tile drains or dual media drains to collect and extract the groundwater downgradient of the contamination plume. This system is most useful in formations with low transmissivity and when the flow of contaminated groundwater must be controlled over a large area. It creates a continuous zone of influence in which groundwater flow is directed toward the drain. The major activities associated with construction of subsurface drains are trench excavation, trench stabilization, and installation of a perforated drain pipe and associated filter materials. The barrier drain extraction system is well-demonstrated and highly reliable. Drains installed to depths in excess of 30 feet are difficult to construct and generally do not perform well. Barrier drains involve long-term operations and do not treat the groundwater; but act only as a preliminary collection step. The cost to install barrier drains is relatively low to moderate. The hydrogeological characteristics at NAB Little Creek sites need to be properly modeled before this option can be considered.

Extraction Wells: Extraction well systems consist of a series of wells installed into a stratum to remove contaminated groundwater. These systems are most useful in formations with high transmissivity. They can be installed and screened at any desired depth and location. The zone of influence and amount of water that can be pumped from these wells depends primarily on the aquifer characteristics. The extraction wells do not directly reduce the volume or toxicity of the contaminated water, but are used rather as a support process prior to implementing a treatment technology. Additionally, the wells can be used for gradient control to reduce the rate of contaminant migration. A scheme of varying the flow rates can be used to optimize the removal from a specific zone of contamination. The extraction well system is well-developed and highly reliable at hazardous waste sites. The cost of extraction well systems depends on the number of wells, their depths, and the rate of pumping. The relative costs for this technology are moderate. This technology option will be considered for sites, where ex-situ groundwater treatment is deemed necessary.

O.5: Soil Control Technologies

Soil Monitoring: Soil monitoring would include periodic sampling and analysis of surface and subsurface soils. Soil monitoring technology is not effective in achieving response objectives or in meeting ARARs. However, soil monitoring is required to monitor soil contamination and to evaluate the progress and effectiveness of any soil remediation that is implemented at the site. Even if no soil remediation is implemented, monitoring at hazardous

waste sites is usually conducted to determine whether contaminant concentrations have decreased to safe levels though natural flushing and/or attenuation. Soil monitoring is easily implemented, but would require long-term management efforts. At NAB Little Creek, soil monitoring will have to be conducted if No Action or Limited Action alternatives are chosen at sites 7, 9, 10, 11, 12, and 13.

Containment Technologies: Containment Technology for in-situ containment of contaminated soils is capping the contaminated areas with a low permeability cover to reduce infiltration and subsequent leaching of contaminants from the soil into the groundwater, and to reduce potential direct contact hazards.

Capping: Three capping options will be considered: 1)a RCRA cap, 2) a multi-media (soil and HDPE liner) cap, and 3) an asphalt cap.

A RCRA cap is a multi-layer cap satisfying the requirements of EPA's RCRA Guidance Document, (Surface Impoundments, Liner Systems and Freeboard Control, July 1982). The RCRA cap consists of a two-foot thick compacted clay layer overlain by a high density polyethylene (HDPE) synthetic membrane liner, HDPE synthetic drainage net, and 2 to 3 feet of clean fill and topsoil. The topsoil layer would be vegetated with grass to resist erosion.

A multi-media cap is a simplified version of the RCRA cap, and would consist of a 6-inch sand layer, overlain by an HDPE liner and synthetic drainage net, overlain by 2 to 3 feet of cover soil, and vegetation to resist erosion.

Asphalt is a low permeability material that can function in a similar manner as the other caps, but provides a usable area for parking or other land use needs. An HDPE liner can be included in the design to make the asphalt cap perform as well as the other caps in minimizing or eliminating infiltration.

The placement of a cap over the contaminated soil areas of the site would provide containment and reduce potential surface contact hazards posed by contaminated soils. A cap is also effective in minimizing infiltration and subsequent leaching of contaminants in underlying soil.

A RCRA cap and a multi-media cap are both considered extremely effective in limiting infiltration, and subsequent leaching of contaminants from the underlying soil. Both caps would require periodic maintenance to prevent excessive erosion and to ensure the continued integrity of the liners.

An asphalt cap without a liner is not as effective in limiting infiltration as the other caps because asphalt is susceptible to cracking due to natural freeze/thaw cycles. However, an asphalt cap underlain by an HDPE liner would be equally as effective in minimizing infiltration as other multi-layer caps. Periodic maintenance of the asphalt would be required to ensure its continued integrity.

All three types of caps are equally effective in reducing the potential for direct contact with contaminated soil, but none of the three technologies would be able to deal directly with the contaminated sediments in the Paradise Creek.

All three types of caps could be implemented on NAB Little Creek Sites property to prevent direct contact with surface soils and limit infiltration through the subsurface contaminated soils. The RCRA cap would be the most difficult to implement because the overall thickness of a typical RCRA cap is 5 to 7 feet. If surface soil contamination surrounds existing buildings or other structures, constructing a RCRA cap can be very difficult around those buildings. There is no such concern at landfill sites at NAB Little Creek, namely sites 7, 9, and 10; but sites 11, 12, and 13 have many existing buildings. A multi-media cap would be easier to construct since it can be only 3 to 4 feet thick. An asphalt cap would be the most desirable if current and future land use is to be considered since the asphalt cap could also be used for parking, etc. With the RCRA and multi-media caps, the capped area must be protected from future land use in order to protect the integrity of the cap.

O.6: Soil Removal Technologies

The potentially applicable technology for removal of contaminated soil is excavation. Excavated soil would be treated or disposed, and the excavation would then be backfilled with clean fill.

Excavation: The horizontal and vertical extent of contamination in surface and subsurface soils has not been delineated precisely. Therefore, the extent of excavation required to achieve the target cleanup levels is difficult to estimate. However, excavation option at sites 7, 9, and 10, for example, may involve a million cubic yards of soils. Excavation of such amount of soil is a relatively large operation and may be difficult to implement without disturbing the adjoining site operations. Structural supports are usually required during excavation of contaminated soil near the existing structures; however, this may not be a concern at NAB Little Creek landfill sites, viz. 7, 9, and 10. Excavation at sites 11, 12, and 13, if any, will have to be carried out with proper precautions. Excavation would require staging areas for equipment, a stockpile area, and equipment operating areas.

Excavation uses standard earthmoving equipment which is readily available, but the excavation would have to be carefully staged and managed in order to reduce the possibility of spreading contamination via fugitive dust emissions, storm-water runoff, and infiltration of precipitation through contaminated soil stockpiles. There are risks of exposure to dust containing metals and volatilization of VOCs during excavation of the contaminated materials. Ambient air monitoring an appropriate health and safety measures would be required in order to protect worker health and safety.

Excavation is not intended to reduce the toxicity or volume of contaminated soil; however, it is required for subsequent treatment or off-site disposal.

O.7: Disposal Technologies

Soil disposal can be accomplished either at on-site or off-site landfills. Given the site background and current usage at NAB Little Creek, on-site landfill option is ruled out at all sites except site 7, which may need reconstruction and/or reinforcement prior to any such use. Disposal at off-site landfills would involve transportation by a licensed hazardous waste hauler, preparing appropriate manifests, following all DOT regulations, and finally disposing the soils at an approved, permitted commercial facility. Facilities located in Virginia, the Carolinas, and Maryland would probably be used. Additional analysis such as TCLP may be required to determine the fate of the contaminated soil. For those areas where TCLP results are negative, the waste will have to go to a RCRA permitted facility.

Groundwater disposal can be accomplished either by reinjection, surface water discharge, transportation to a local POTW or a commercial treatment facility. Either reinjection or surface water discharge would require NPDES permit, and these options can be considered only if extracted groundwater is treated to MCLs. It is not yet determined whether a local POTW capacity is available. Disposal in a commercial treatment facility would require permitting similar to soil disposal. These options can be further evaluated only after groundwater remediation strategy is further refined.

O.8: Treatment Technologies - Soil

A large number of treatment technologies are applicable to the contaminants of concern in the soil. some of these technologies can be applied in-situ (without excavating the soil) while others require excavation prior to treatment (ex-situ). On-site treatment can be accomplished by mobile treatment units that can be set up at the site on a temporary basis, or by a semi-permanent treatment system which may be constructed at NAB Little Creek Sites. On-site treatment is usually more cost-effective than off-site treatment because of the elimination to transportation

costs, which typically comprise a large portion of overall costs for off-site options. Potentially applicable treatment technologies for soil include:

Physical Treatment: Physical treatment involves technologies which separate chemicals from the soil, whereupon the soil may then be backfilled or treated further by other methods. Physical treatment processes that may be applicable at NAB Little Creek Sites include stabilization (both in-situ and ex-situ), solids processing (including crushing, grinding, or sieving to size-segregate material for subsequent treatment), solvent extraction, soil vapor extraction, soil washing, and in-situ soil flushing.

Solvent Extraction/ Chemical Extraction: Organic solvents, amines or other polar solvents, are used to extract organic hazardous compounds from the soil/sludge matrix. With proper mixing and temperature, high removal efficiencies are achieved in this process. This technology is suitable for sludges contaminated with oils, organics, and heavy metals. The extracting solvent must be immiscible with the aqueous phase and the density differential enables eventual separation. Use of this technology requires excavation and possibly transport of site soils. Further, the treatment does not destroy the contaminants.

Soil Vapor Extraction: In-situ vacuum extraction removes VOCs from soil in the vadose or unsaturated zone. Subsurface organic contaminants are "vacuumed up" via a well; vapor and liquids are separated; and vapor is released to the atmosphere after activated carbon treatment. This is a simple technology and does not require highly trained operators or sophisticated equipment. Recovery rate is a function of volatility of the contaminants, porosity of the vadose zone soils, and depth to groundwater. Use in saturated, tarry or clayey soils is greatly restricted.

Soil Washing: Soil washing mixtures employ water, surfactants, oxidizing or reducing agents to extract contaminants in the soil matrix. Many vendors have developed propriety reagents to enhance soil washing. Soil washing is effective for removal of heavy metals and other inorganics from coarse soils. Washing fluids with good extraction coefficients and proper mixing are the keys to the success of this process. This technology has recently been selected at many remedial sites. Soil washing is limited in its effectiveness to remove organics from soil.

Soil Flushing: Soil washing, conducted in-situ, is soil flushing. However, the injection/recirculation of washing fluids, soil characteristics, and uniformity become important parameters. Soil porosity and mobility of washing fluids and contaminants have to be well demonstrated before undertaking an in-situ remedy. Also, the washing fluids and solvents need to be less volatile and non-toxic, and safe and easy to handle. Soil flushing is not very effective in removing organics in soil.

Chemical Treatment: Chemical treatment processes involve chemical reactions with specific contaminants. These reactions modify the contaminant so it is no longer hazardous or so that it may be removed form the soil by some other process, often a physical removal. Neutralization and ESD are two technologies probably applicable to site soils.

Neutralization: Neutralization is the process of changing the pH of the solution from acidic (below 7) or alkaline (7-14) to a neutral value of 7. Waste acids and alkalies are neutralized to eliminate their reactivity and corrosivity. The process should be performed in a well-mixed system. Care should be taken to ensure completeness, compatibility, and prevent any formation of toxic products. This can be an inexpensive process if waste acids are used to neutralize waste alkalies (EQUALIZATION). Applicable only if liquid waste, either acidic or alkaline, is present. Neutralization or pH adjustment can also be used as a pretreatment for other processes.

Electro-Acoustic Soil Decontamination (ESD): This process is based on the synergistic application of a d.c. electric field and an acoustic field to contaminated soils to increase the transport of leachants through the soils. Applicability has been demonstrated for removal of heavy metals such as Zinc and Cadmium, and other ionic compounds. The technology is still on a laboratory scale. It can be applied in-situ.

Biological Treatment: Biological treatment uses microorganisms to biodegrade organic contaminants. Both aerobic (requires oxygen) and anaerobic (does not require oxygen) processes can be utilized, dependent upon the compound requiring treatment. Biodegradation (both in-situ and ex-situ) may be applicable at NAB Little Creek Sites.

Aerobic Biological Treatment: Organic molecules, primarily hydrocarbons, are oxidized to carbon dioxide and water by microorganisms. These microorganisms require adequate levels of inorganic and organic nutrient growth factors, oxygen, and sufficient biologic space. Aerobic treatment is used to treat aqueous waste with low levels (BOD < 10,000 ppm) of non-halogenated organics and can easily handle variable wastewater and pollutant loads. The treatment requires consistent, stable operating conditions. The process can be conducted in aerated lagoons, lined ponds, or in a trickling filter design. Large surface area and retention time are key factors to ensure proper mixing. Light/nutrient imbalances may result in algae blooms. Most of the organic contaminants can be destroyed in this manner if sufficient microbial population, nutrients, oxygen, and biological mobility are present.

Anaerobic Digestion: Reduction of organic matter is achieved in an oxygen-free environment. A number of proprietary engineered processes based on this principle are being marketed. An airtight reactor is usually required to control the process and to sustain the anaerobic mechanism. Anaerobic processes can handle organic loads higher than the aerobic process, and aqueous wastes with low to moderate levels of organics can be treated. Certain halogenated organics are treated more efficiently in anaerobic methods.

In-Situ Biological Treatment: Organic contaminants in subsurface soils and groundwater are treated by special strains of cultured bacteria and naturally occurring microorganisms. Usually the process is aerobic, and proper pH, temperature, and oxygen concentration should be maintained. Nutrients have to be pumped into the system. Interaction of microbes, oxygen, and nutrients is facilitated in a relatively coarse/ permeable soil. Care must be taken not to drive the contaminants into deeper zone by minimizing their mobilization during the process. Moderate levels of risk reduction can easily be achieved by this process. This technology has not yet been fully demonstrated. A pilot-scale study is highly recommended prior to a full-scale setup.

Composting: Composting involves the storage of highly biodegradable and structurally stable material (e.g. wood chips) with a small percentage (less than ten percent) of biodegradable waste. Adequate aeration and optimum temperature and moisture conditions have to be maintained. Composting is relatively insensitive to toxicants. It has not yet been widely used in the hazardous waste field, but it is potentially applicable to soils and sludges with high levels of organic contaminants. It is imperative to collect composting leachate and treat it if required.

Land Farming/Land Treatment: This is a mechanism to conduct aerobic digestion on-site. The contaminated soil is excavated and staged in the designated area, in a layer of pre-determined thickness. Better control of the operating conditions is possible as compared with the in-situ option. The reaction times are higher, but costs are lower as compared to a bioreactor. The phenols, PAHs, and VOCs in soils can be destroyed in this manner.

Thermal Treatment: Thermal treatment technologies utilize elevated temperatures to modify or destroy contaminants in the soil. Thermal treatment processes that may be applicable at NAB Little Creek Sites include low temperature thermal desorption, incineration, in-situ vitrification.

Rotary Kiln Incineration: Wastes and auxiliary fuels are introduced to the high end of an inclined, rotating kiln. Ash residue and exhaust gases are collected at the low end of the kiln and may be further treated. This technology is intended primarily for solid organic waste. Explosive waste and wastes with high inorganic salts/heavy metals require special evaluation. Lead emissions can pose a serious problem in this setup if lead is also present.

Vitrification: Hazardous wastes are converted into a glassy substance utilizing very high temperatures. This is usually done in-situ by inserting large electrodes into the soil, with graphite providing the starter path. Between 1000 to 2000 °C, many organics are destroyed by pyrolysis, and inorganics are immobilized when the soil melt cools down. The process is effective only on soils with significant levels of silicates. The process has been applied

to radioactive waste. Environmental impacts from off-gas must be considered. The process is more appropriate to soils with high levels of heavy metals and silicates.

Low Temperature Thermal Desorption (LTTD): Volatile and semi-volatile organics can be removed at moderate temperatures (up to 600 °C) from the contaminated soil. An inert carrier gas is typically used to transport volatilized organics and water. Organics are condensed and treated separately. Several different desorber/dryer designs are available. The process is designed to separate organics without any decomposition. Levels below 1 ppm are usually accomplished. Some of the less volatile chemicals may not be volatilized at low temperatures, especially if they are bound in a tarry sludge matrix.

Stabilization: Stabilization, also referred to as solidification or fixation, applies to processes involving mixing of a setting agent with excavated or in-situ contaminated soils to form a durable product in which contaminants are chemically bound and/or entrapped by the solidified mass. Typical additives include Portland cement, flyash, kiln dust, lime, soluble silicates, gypsum, and various combinations of these materials.

The purpose or goal of stabilization is to improve the handling and physical characteristics of sludges, and/or to reduce the mobility of the contained pollutants. Stabilization may be required for residual sludges or ash from other types of treatment processes prior to disposal.

Organic wastes are not effectively immobilized by some stabilization processes. For example, organics interfere with the setting reaction of Portland cement, affecting the durability and the characteristics of the final product. Generally, this precludes the use of cement stabilization as a treatment for organic wastes. Recently, however, it has been reported that PCB-contaminated soils and sediments have been successfully treated with the addition of organophilic clays to reduce PCB mobility.

Silicate-based processes involve the addition of a source of silicates along with a setting agent. Silicates are often added in the form of fly ash, blast furnace slag, cement kiln dust, or soluble silicates (e.g., potassium or sodium silicate). The setting agent is typically Portland cement or lime, although other suitable materials are available.

In-situ stabilization (soil mixing) of the surface and subsurface contaminated soils can be performed using equipment and technology available form server vendors. Stabilization of excavated soil or residual treatment sludges can be performed in mixing pits. Ex-situ stabilization can also be performed in batches, but the preparation of materials involves the additional expense of excavation and additional risk of exposure of site workers.

Stabilization option can be applicable to soils at sites 7, 12, and 13 if treatment is the preferred method.

Solids Processing: Solids processing utilizes sorting, crushing, grinding, shredding and screening to either sort out undesirable materials or modify the size of solid materials. Some excavation may occur beneath concrete or asphalt drives and pads. Additionally, concrete rubble and debris have been used as fill in some areas of the site.

Screening of site wastes may be useful to help dewater and size-segregate debris prior to treatment. Screening may be applied to a wide range of soils an mixed debris. Separation of soils according to size helps improve production from crushing and grinding operations. Crushing and grinding may be used to reduce the size of solid wastes and mixed debris prior to treatment or disposal. Reducing the size of the waste particles can enhance subsequent waste treatment: 1) by liberating the hazardous waste form inert material; 2) by increasing specific surface area; and 3) By breaking down oversized particles resulting in uniformly sized particles for subsequent physical separation.

Solids processing is a well established technology which utilizes readily available equipment. Physical hazards as well as the potential for dust emissions would have to be addressed.

O.9: Treatment Technologies - Groundwater

Groundwater treatment may become a significant issue for sites where aquifer restoration is the remedial action objective.

Treatment technologies can be located on-site using mobile units or more permanent treatment plants contained within buildings, or located off-site at a treatment plant facility. Although the same remedial technologies are applicable for on-site or off-site treatment of contaminated groundwater, on-site treatment should be considered first to minimize transportation and handling costs. The applicability of complete or partial on-site treatment depends primarily on the availability of land for the treatment facilities. It is expected that the groundwater treatment system would require a relatively large capacity and, therefore, off-site treatment would not be technically practical and cost-effective. Transportation to a licensed RCRA facility is not feasible due to the distance from the site of such a facility. The available technologies for treating groundwater include biological, physical and chemical processes.

Biological Treatment: Biodegradation is a treatment process whereby hazardous chemical substances (primarily organic chemicals) may be transformed to non-toxic or less toxic metabolites through the enzymatic action of microorganisms. Under optimum conditions, and through the use of appropriate organisms, such degradation mechanisms may result in the complete mineralization of organic chemicals to carbon dioxide, water or methane, and biomass. Biodegradation of selected organic chemicals can be conducted through the use of chemical-specific aerobic or anaerobic microorganisms. Such organisms may be indigenous species that have been isolated and developed through various enrichment techniques or exogenous bacteria which were isolated from other sites or waste streams and developed for commercial use, or they may be cultures that have been genetically engineered to degrade various persistent synthetic compounds.

Biological treatment systems are dependent upon the ability of the microorganisms to biodegrade various organic substrates. Studies have shown that the availability of oxygen (for aerobic systems), and micronutrients like phosphorus and nitrogen, the proper pH, and temperature, are important parameters to be considered for biological treatment systems to function properly. Additional factors that may also be necessary to biodegrade various organics include trace inorganic elements, cosubstrates such as glucose or other readily degraded organics, or possible analog enrichment (the use of a similarly structured biodegradable compound to promote enzyme production to biodegrade the compound of interest). Several factors may have a negative influence on biological systems such as the presence of toxins or the formation of toxic metabolites, preferred substrates and contaminant concentrations that are high enough to be toxic or inhibitory. In addition, it is possible that in some cases the groundwater contaminant concentrations are below the threshold concentration where enzymes are produced and thus result in no degradation. Often more than one species of microflora may be required to accomplish the complete degradation of a given substrate. One species may be able to transform the parent compound, but may be unable to further degrade the metabolic byproducts, and additional species are required to complete the biodegradation process. Numerous studies have been conducted to determine the effectiveness of specific classes, genera, or species for the degradation of specific compounds or classes of compounds. Although, these studies are very informative, they are often not representative of actual environmental conditions or biological systems. Many types of microorganisms are typically required to completely mineralize organic compounds or organic waste streams. In general, mixed microbial cultures have a greater biodegradative capacity and provide a better probability to reduce organic compounds to carbon dioxide and water.

Biological treatment could be applied to groundwater in-situ, or in a bioreactor system after collection/extraction. The processes can be classified as aerobic or anaerobic, depending on whether the microorganisms used thrive in the presence or absence of oxygen, respectively. Aerobic biodegradation is achieved in the presence of oxygen and is the most widely used biological process. Aerobic process options include activated sludge, trickling filters, and rotating biological contactors. Anaerobic biodegradation is performed by microorganisms that do not require oxygen. The most common anaerobic process, anaerobic digestion, produces methane and carbon dioxide as byproducts of the degradation process. New biotechnologies are considered to be those which use genetically

engineered and mutated microorganisms. Theoretically, these organisms can be developed to feed on only the major site contaminants. These organisms are then released into the groundwater. After all the organic contaminants are destroyed, the microorganisms die from lack of food. This treatment method is still in the experimental stages.

Physical Treatment: Physical treatment processes utilize the differences in physical properties of the contaminants to separate them from water. The water may then be discharged or treated further by other methods. Potentially applicable physical treatment technologies include sedimentation, filtration, air and steam stripping, carbon adsorption, and reverse osmosis.

Sedimentation/Clarification: Sedimentation or clarification is a process used to remove settleable suspended particles from water. The equipment used produces quiescent hydraulic conditions so that gravitational forces are able to settle out the unstable solids. The typical designs of sedimentation tanks involve a sloping bottom to collect the settled solids and an overflow weir for the supernatant (clear) liquid. Once the particles reach the bottom, they are generally removed as an underflow, and their movement is assisted by a series of slowly moving paddles, rakes or arms. This technology can be used alone or in conjunction with precipitation.

Filtration: Filtration is a process in which suspended and colloidal particles which are not readily settleable are removed from water by physical entrapment on a given media. Fluid flow through the filter medium may be accomplished by gravity or it may be pressure induced. Beds of granular material like sand and anthracite are commonly used filters in water treatment. Other types of filters include vacuum filters, plate and frame filters, and belt filters. These are often used to dewater sludges produced by processes like sedimentation and chemical precipitation. Packed beds of granular material are usually backwashed to remove the filter cake. The collected solids will require disposal and their costs will depend on whether the material is considered hazardous or non-hazardous.

Air and Steam Stripping: Air stripping is a mass transfer process in which volatile contaminants in water are transferred to the gaseous phase. This process works best on contaminants with high volatility and low solubility. Generally, organic compounds with a Henry's Law constant greater than or equal to 3.0 liter-atm/mole can be readily removed from groundwater by air-stripping. Several contacting systems can be used, such as mechanical surface aerators, diffused aeration, spray or tray towers, open channel cascades, spray fountains, and counter-current packed towers. Surface aeration and counter-current packed towers are considered to be the most energy efficient systems. Air-stripping might require consideration of techniques to mitigate atmospheric discharge of contaminants in the exhaust gas. Packed tower systems are more amenable to air pollution controls. Generally, vapor phase carbon adsorption beds, flare burner systems, and, catalytic incineration are used for capture and/or destruction of the volatilized contaminants. In the counter-current packed tower configuration, water is distributed over the top of the packing material, while air is forced upward from the bottom of the tower. Primary factors which govern the efficiency of the process include the air-to-water ratio, pressure drop, tower height, surface area of the packing material, contact time, and temperature of the influent. Pretreatment of suspended solids and inorganics like iron and manganese, may be necessary to avoid deposition on and subsequent clogging of the packing material.

Steam-stripping uses steam to remove organics from aqueous waste in much the same way that air-stripping works, but because of the heat involved in the process, is sometimes more effective on some contaminants than air stripping alone. It is generally used for removal of organic compounds which are relatively less volatile and more soluble, and can handle a wider concentration range of contaminants in the influent stream. The towers used for steam stripping are generally smaller than those used for air stripping because the higher temperatures used provide a greater driving force for removal. However, the energy costs are generally much higher. Steam stripping is generally not used unless the contaminants include compounds like methyl-ethyl ketone, xylenes, etc.

Carbon Adsorption: Carbon adsorption removes organics from aqueous wastes via surface attachment between the organic solutes and the large internal pore structure of the activated carbon. This attachment within the pores is due to a force of attraction known as Van der Waals force. The major parameters which influence the

effectiveness of the adsorption include the solubility of the organic compound, the pH and temperature of the influent, empty bed contact time, and the surface area/volume ratio of the adsorbent. Typical activated carbon adsorption treatment systems include gravity flow or pressure flow columns in series and/or parallel configurations with backwashing capability. Granular activated carbon is generally used with loading rates of 0.5 to 5.0 gpm/sq.ft. This technology can treat single-phase waste streams with high molecular weights, high boiling points, low solubility and polarity, and relatively non-polar chlorinated hydrocarbons and aromatics. Concentrations of up to 10,000 ppm can be effectively treated using carbon adsorption; however, the process works best for aqueous streams with suspended solids' concentration less than 100 ppm and concentration of dissolved inorganics, oil, and grease of less than 10 ppm. For these reasons, some pretreatment of the aqueous waste stream may be necessary. The spent carbon must be either regenerated at an appropriate facility, or disposed of as a hazardous material.

Reverse Osmosis: Osmosis is a process which occurs whenever two solutions of different solute concentration levels reach an equilibrium across a semi-permeable membrane. The solvent (water in this case) will naturally flow from the less concentrated solution into the more concentrated solution. To reverse this process, the solution with the high concentrations must be pressurized to a level higher than the osmotic pressure. At sufficiently high pressures, usually 200-800 pounds per square inch (psi), the water will flow out of the more concentrated solution, leaving the contaminants trapped on the other side of the semi-permeable membrane. The volume of the concentrated waste is generally 10 to 20 percent of the feed volume. This concentrated waste will require additional treatment which is usually expensive. Reverse osmosis has been demonstrated to be effective for treatment of brackish waters and aqueous metal wastes, and recent findings indicate that it is useful in removing some specific organics from solution. The effectiveness of this process is highly dependent on the chemical composition of the waste solution to be treated and the characteristics of the membrane.

Chemical Treatment: Chemical treatment processes generally involve destruction of hazardous substances by reaction with other chemical species to convert them into nonhazardous gases, liquids or solids. Potentially applicable process options include ion exchange, chemical precipitation, oxidation/reduction, and ultra-violet (UV) radiation induced photolysis. Chemical oxidation with ozone or hydrogen peroxide enhanced by UV photolysis is often a very effective combination and is discussed below.

Ion Exchange: Ion exchange is a process in which toxic ions are removed from solution by being exchanged with relatively harmless ions held by the ion exchange material. Both organics and inorganics can be removed by this process. However, removal of inorganics is more common. Ion exchange resins are manufactured for removal of a wide variety of organic and inorganic ions. A practical upper concentration limit for ion exchange is about 2500 to 4000 ppm. Contaminant concentrations in the groundwater at NAB Little Creek sites are well below these levels. Due to the large variety of ions present in the water, removal to levels below ARARs may be difficult. Generally, a train of resin beds in series containing different resins for organics, cation and anion removal are typically used. The beds have to be monitored for breakthrough and must be regenerated using a wide variety of regeneration chemicals which may themselves be hazardous. Ion exchange can be used both as a pretreatment and as a polishing step.

Chemical Precipitation: Precipitation is a physical and chemical technique that can be used to remove metals from an aqueous stream. The metals can be precipitated out of solution by changing the chemical equilibrium of the solution. It is generally achieved by adding a chemical that reacts directly with the metal to form an insoluble product. When used prior to other treatment technologies, this process eliminates the probability of reduced efficiency due to dissolved metals precipitation. The pH of the waste stream can be adjusted to optimize the precipitation process. Usually, the pH varies between 8 and 12. Metals can be precipitated as hydroxides, carbonates, and sulfides. Typical precipitating agents include calcium oxide, caustic soda, sodium sulfide, ferrous sulfide, and hydrogen sulfide gas.

Chemical Oxidation Enhanced by UV Photolysis: Chemical oxidation enhanced by UV photolysis is an emerging technology for cleanup and destruction of organics in groundwater. Commercial applications using hydrogen

peroxide and ozone as the oxidant have been developed. UV light reacts with hydrogen peroxide and/or ozone molecules to form hydroxyl radicals. These very powerful chemical oxidants then react with the organic contaminants in the water. In addition, many organic contaminants absorb UV light and become more reactive to chemical oxidants. If carried to completion, the end products of the oxidation process are carbon dioxide and water. Both hydrogen peroxide and ozone form hydroxyl radicals under UV light catalysis.

The UV/oxidation treatment technology may be used to oxidize a variety of chlorinated hydrocarbons, including PCE and TCE. UV/oxidation will not eliminate inorganic contaminants; however, they could be removed by precipitation prior to allowing the feed stream to enter the UV/oxidation unit. The system has no filtering or adsorption media to dispose of or regenerate, and treats groundwater contaminated with VOCs without air emissions or generation of hazardous wastes. There is no secondary waste management necessary.

Design of a UV/oxidation treatment system is dependent upon many variables including the type and concentration of organic contamination, the light transmittance of the water, and the type and concentration of dissolved solids. Pretreatment of the contaminated groundwater may be necessary to reduce the suspended solids content, since excessive suspended solids can occlude the UV light, thus decreasing the effectiveness of the system. Additionally, precipitation of metals may be necessary to reduce scaling and fouling of the unit.