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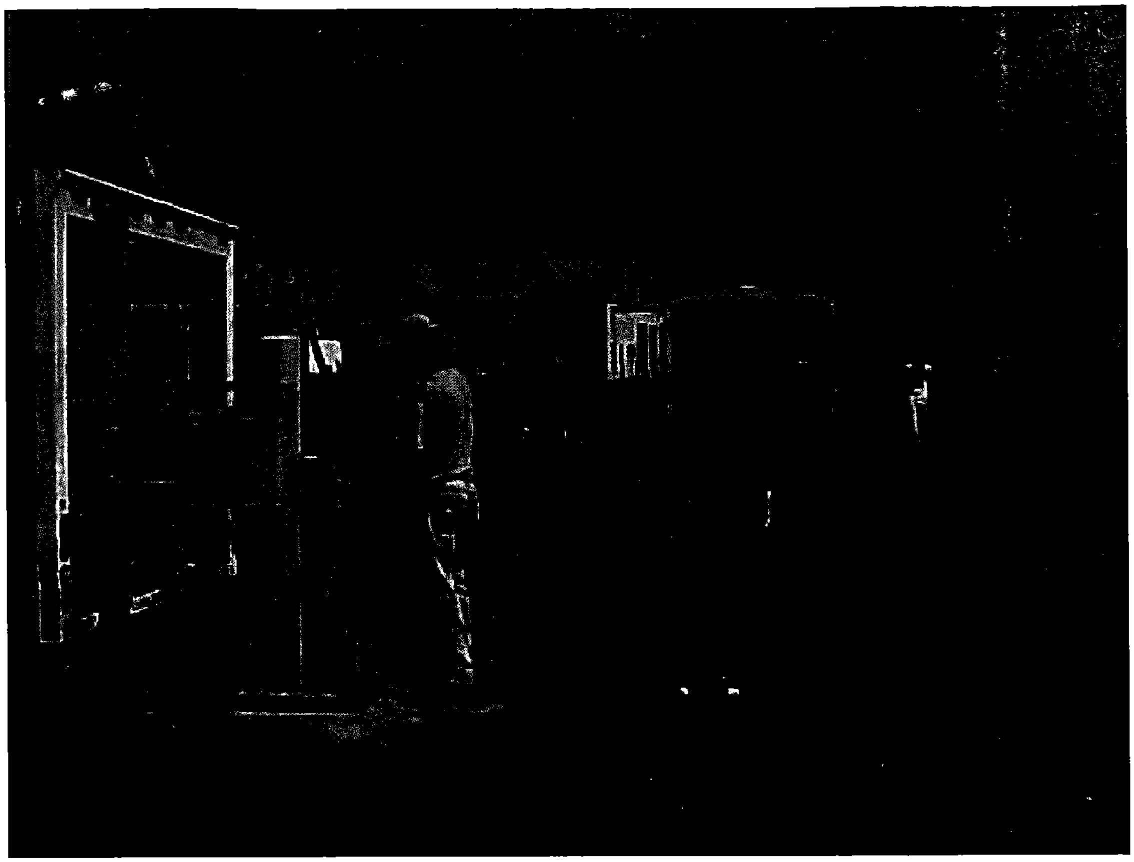
DRAFT FEASABILITY STUDY REPORT WITH REVOCATION LETTER LIGHTER AMPHIBIOUS RESUPPLY CARGO (LARC) 60 MAINTENANCE AREA FORT STORY VA
3/1/2005
MALCOLM PIRNIE

DRAFT 0156

FEASIBILITY STUDY REPORT
LARC 60 Maintenance Area
Fort Story, Virginia



U. S. Army Transportation Center
Fort Eustis, Virginia

and

U.S. Army Corps of Engineers
Baltimore District

March 2005

0285-783

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MALCOLM PIRNIE
INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

May 30, 2008

Ms. Joanna Bateman
Remedial Project Manager
U.S. Army Garrison
IMNE-EUS-PW-E, Building 1407
1407 Washington Blvd.
Fort Eustis, VA 23604-5306

Re: **Revocation of the Draft Feasibility Study Report**
LARC 60 Maintenance Area Site, Fort Story, VA
Contract W912DR-05-D-0004

Dear Ms. Bateman:

Malcolm Pirnie, Inc. was contracted by the U.S. Army Corps of Engineers (USACE), Baltimore District to conduct a Remedial Investigation (RI) and Feasibility Study (FS) at the Lighterage Amphibious Resupply Cargo (LARC) 60 Maintenance Area site at Fort Story, Virginia. The Final RI Report was completed in December 2002 and recommended a Feasibility Study to evaluate remedial alternatives for remediation of groundwater contaminated with chlorinated volatile organic compounds (VOCs) underlying the LARC 60 site. The Draft FS Report was submitted to the Virginia Department of Environmental Quality (VDEQ) in March 2005 which VDEQ provided comments to in December 2005. However, several investigations (three groundwater monitoring events and a Groundwater Pilot Scale Study) have been conducted at the site since finalization of the RI Report, which have changed the recommended future action for the site.

As discussed in the September 2007 Final RI Report Addendum, **no further action** (NFA) was recommended for the LARC 60 site based on the limited contamination detected in site groundwater and that no potential unacceptable human health or ecological risks were identified. The groundwater monitoring program clearly exhibited a decreasing trend in contaminant concentrations with no exceedences of the MCLs noted during the 2007 groundwater monitoring event, which focused on wells that previously had been impacted with VOCs above their respective MCLs. This recommendation was approved by VDEQ provided that two additional groundwater monitoring events were conducted after finalization of the Decision Document to verify that contaminants of concern remain below EPA maximum contaminant levels (MCLs).

MALCOLM PIRNIE

INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

Based on the Final RI Report Addendum recommendation of NFA and guidance provided by the U.S. Army Environmental Command and VDEQ, all parties agree a letter be written to officially revoke the submission of the Draft FS Report. Comments received from VDEQ on this document will be retained in the facility files; however, a response to comments letter will not be submitted.

We look forward to further discussions relative to this site.

Very truly yours,

MALCOLM PIRNIE, INC.

Anthony K. Pace
Project Manager

akp
2118-131-999

Enclosures

C: W. Smith, VDEQ

TABLE 6
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Well ID and Results																RBCs (1)
	6MW-1				6MW-2				6MW-3S				6MW-3D				
	1995	2000	2003	2004	1995	2000	2003	2004	1995	2000	2003	2004	1995	2000	2003	2004	
Acetone	5 U	5 U	NT	NT	5 U	NT	NT	**270 D**	5 U	5 U	5 U	**17 J**	5 U	NT	5 U	**3.3**	550
Benzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	**0.6 J**	0.5 U	5 U	NT	5 U	0.5 U	0.34
Bromodichloromethane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.17
2-Butanone (MEK)	5 U	5 U	NT	NT	5 U	NT	NT	**21**	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	**2.5**	700
Carbon disulfide	5 U	5 U	NT	NT	5 U	NT	NT	**0.83**	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	100
Chloroform	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.15
Chloromethane	5 U	5 U	NT	NT	5 U	NT	NT	**0.23 JB**	5 U	5 U	5 U	**0.84 J**	5 U	NT	5 U	**0.21 J**	19
Cyclohexane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	---
Dibromochloromethane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.13
1,2-Dichlorobenzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	27
1,1-DCA	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	80
1,1-DCE	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	**1.3 J**	5 U	NT	5 U	0.5 U	35
cis 1,2-DCE	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	**2 J**	**1 J**	**100**	5 U	NT	5 U	**0.33 J**	6.1
trans 1,2-DCE	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	**0.87 J**	5 U	NT	5 U	0.5 U	12
Ethylbenzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	130
Isopropyl benzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	---
Methylcyclohexane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	630
Methylene chloride	5 U	5 U	NT	NT	5 U	NT	NT	**0.52 B**	5 U	5 U	5 U	**3.3 JB**	5 U	NT	5 U	**0.47 JB**	4.1
MIBK	5 U	**50**	NT	NT	5 U	NT	NT	2.5 U	5 U	**44**	13 U	2.5 U	5 U	NT	13 U	2.5 U	630
Styrene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	160
Tetrachloroethene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	**0.4 J**	**62**	5 U	NT	5 U	0.5 U	0.1
Toluene	5 U	5 U	NT	NT	5 U	NT	NT	**0.29**	5 U	5 U	**0.8 J**	0.5 U	5 U	NT	**0.9 JB**	**0.42 J**	75
1,2,4-Trichlorbenzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.72
Trichloroethene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 u	**1.3 J**	**1 J**	**140**	5 U	NT	5 U	0.5 U	0.026
Vinyl chloride	5 U	10 U	NT	NT	10 U	NT	NT	0.5 U	10 U	**3.1 J**	**1 J**	**9.7**	10 U	NT	5 U	**0.2 J**	0.015
Xylenes	5 U	10 U	NT	NT	5 U	NT	NT	1 U	5 U	10 U	5 U	1 U	5 U	NT	5 U	1 U	21

Notes:

(1) EPA Region III Risk-based Concentration Criteria for Tap Water

NT - Not tested

J - Estimated concentration (result between MDL and PQL for organics)

B - Detected in associated method blank

Organics detected are bolded and italicized.

Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

TABLE 6
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	6MW-4				6MW-5S		6MW-5D		6MW-6		6MW-7		6MW-8		6MW-9		RBCs (1)
	1995	2000	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	
Acetone	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	550
Benzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	**0.2 J**	0.5 U	0.34
Bromodichloromethane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.83**	5 U	0.5 U	5 U	0.5 U	0.17
2-Butanone (MEK)	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0. 5U	5 U	0. 5U	5 U	0. 5U	700
Carbon disulfide	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	100
Chloroform	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**3.3**	5 U	0.5 U	5 U	0.5 U	0.15
Chloromethane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.18 J**	19
Cyclohexane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	---
Dibromochloromethane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.12 J**	5 U	0.5 U	5 U	0.5 U	0.13
1,2-Dichlorobenzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	27
1,1-DCA	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	80
1,1-DCE	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	35
cis 1,2-DCE	5 U	5 U	5 U	NT	5 U	**1.1**	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.15 J**	5 U	0.5 U	6.1
trans 1,2-DCE	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	12
Ethylbenzene	5 U	5 U	5 U	NT	5 U	0. 5U	5 U	0.5 U	5 U	0. 5U	5 U	0. 5U	5 U	0. 5U	5 U	0.5 U	130
Isopropyl benzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	---
Methylcyclohexane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	630
Methylene chloride	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	**0.2 J**	5 U	**0.15 J**	5 U	**0.14 J**	5 U	**0.44 JB**	4.1
MIBK	5 U	**19**	13 U	NT	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	630
Styrene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	160
Tetrachloroethene	5 U	5 U	5 U	NT	5 U	**0.84**	5 U	0.5 U	5 U	0.5 U	**11**	**0.49 J**	5 U	0.5 U	5 U	0.5 U	0.1
Toluene	5 U	5 U	**0.6 J**	NT	**1 JB**	0.5 U	**1 JB**	0.5 U	**1 JB**	0.5 U	**1 JB**	**0.1 J**	**0.7 J**	0.5 U	**0.5 JB**	**0.15 J**	75
1,2,4-Trichlorbenzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	0.72
Trichloroethene	5 U	5 U	5 U	NT	5 U	**1.7**	5 U	**0.10 JB**	5 U	0.5 U	5 U	0.5 U	**0.5 J**	**0.15 J**	5 U	0.5 U	0.026
Vinyl chloride	10 U	10 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	0.015
Xylenes	10 U	10 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	21

Notes:

(1) EPA Region III Risk-based Concentration Criteria for Tap Water

NT - Not tested

J - Estimated concentration (result between MDL and PQL for organics)

B - Detected in associated method blank

Organics detected are bolded and italicized.

Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

TABLE 6
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	6MW-10	6MW-11	MW-115				MW-117				MW-118				RBCs (1)
	2004	2004	1995	2000	2003	2004	1995	2000	2003	2004	1995	2000	2003	2004	
Acetone	**5.5**	0.5 U	5 U	5 U	5 U	**2.9**	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**3**	550
Benzene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.34
Bromodichloromethane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.17
2-Butanone (MEK)	**4**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**1.5 J**	700
Carbon disulfide	**0.22 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	100
Chloroform	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.15
Chloromethane	**0.31 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**0.26 J**	19
Cyclohexane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**2.7**	5 U	5 U	5 U	0.5 U	---
Dibromochloromethane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.13
1,2-Dichlorobenzene	0.5 U	0.5 U	5 U5	5 U	5 U	**0.16 J**	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	27
1,1-DCA	0.5 U	0.5 U	5 U	5 U	5 U	**0.34 J**	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	80
1,1-DCE	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	35
cis 1,2-DCE	0.5 U	0.5 U	5 U	5 U	5 U	**0.3 J**	**20**	**1,900**	**22**	**24**	5 U	5 U	5 U	0.5 U	6.1
trans 1,2-DCE	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**0.25 J**	5 U	5 U	5 U	0.5 U	12
Ethylbenzene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	**66**	**76**	**29**	**6.8**	5 U	5 U	5 U	0.5 U	130
Isopropyl benzene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**6.2**	5 U	5 U	5 U	0.5 U	---
Methylcyclohexane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**16**	5 U	5 U	5 U	0.5 U	630
Methylene chloride	**0.45 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**0.43 JB**	4.1
MIBK	2.5 U	0.5 U	5 U	13 U	13 U	2.5 U	5 U	250 U	13 U	**4**	5 U	5 U	13 U	2.5 U	630
Styrene	**0.12 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	50 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	160
Tetrachloroethene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	**8.5**	50 U	**2 J**	**0.67 J**	5 U	5 U	5 U	0.5 U	0.1
Toluene	**0.36 J**	**0.17 J**	5 U	5 U	**0.7 J**	0.5 U	**68**	**310**	**1 JB**	**0.15 J**	5 U	5 U	**1 JB**	**0.27 J**	75
1,2,4-Trichlorbenzene	**0.15 JB**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	50 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.72
Trichloroethene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	**18**	50 U	**1 J**	0.5 U	5 U	5 U	5 U	0.5 U	0.026
Vinyl chloride	0.5 U	0.5 U	10 U	10 U	5 U	0.5 U	10 U	**8.6 J**	5 U	0.5 U	10 U	10 U	5 U	0.5 U	0.015
Xylenes	0.5 U	0.5 U	5 U	10 U	5 U	0.5 U	**290**	**450**	**130**	**65**	5 U	10 U	5 U	0.5 U	21

Notes:

(1) EPA Region III Risk-based Concentration Criteria for Tap Water

NT - Not tested

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Organics detected are bolded and italicized.

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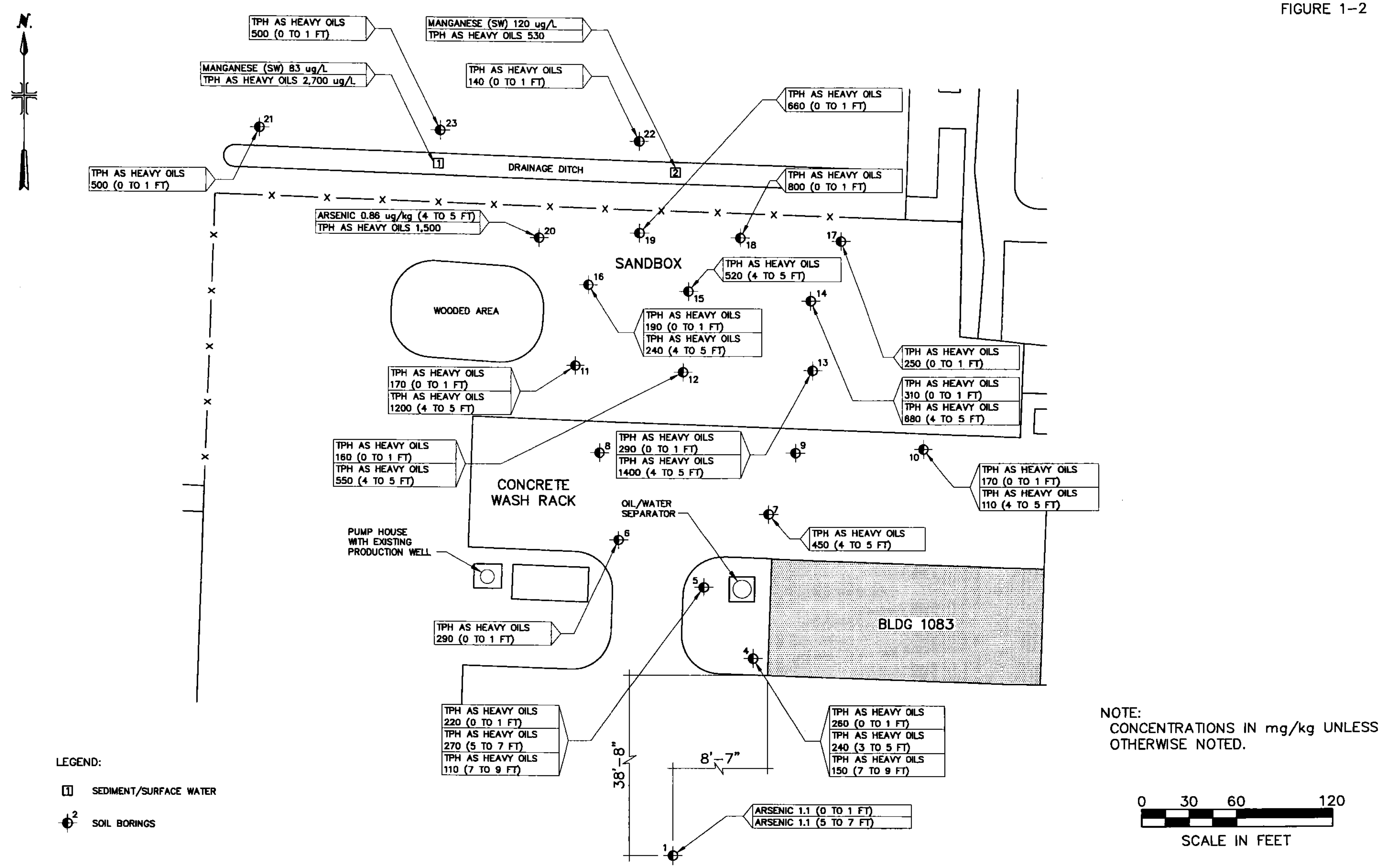
TABLE 3-2
PROCESS OPTIONS EVALUATION AND SCREENING
LARC 60 Maintenance Area
Fort Story, VA

General Response Action	Technologies	Process Options	Description	Effectiveness	Implementability	Cost	Screening Comments	Retain or Reject
No Action	None	None	No action - contaminated media remains in-place.	Low	High	Low	Does not reduce toxicity, mobility or volume of contaminants except by natural attenuation. Does not reduce potential for human or ecological exposure. Retain as baseline alternative as per NCP.	**Retain**
Monitoring	Monitoring	Environmental media sampling	Long term monitoring of groundwater.	Low	High	Low	Necessary to measure effectiveness of any remedial alternative. Will be used in conjunction with other response actions. Does not reduce toxicity, mobility, or volume of contaminants. Does not reduce potential human or ecological risk.	**Retain**
Institutional Controls	Access Restrictions	Posting Signs	Post signs to restrict human exposure to wetland area /wooded area/ and ditches.	Low	High	Low	Does not reduce toxicity, mobility, or volume of contaminants. Does not reduce human or ecological risk.	Reject
		Fencing	Prevent human access to wooded area/ wetland area/ and ditches.	Low	High	Low	Does not reduce toxicity, mobility, or volume of contaminants. Does not reduce human or ecological risk.	Reject
	Land Use Restrictions	Land Use Restrictions	Restrict current and future use of the site.	Low	High	Low	Does not reduce toxicity, mobility, or volume of contaminants. Does not reduce ecological risk.	Reject
Containment	Barrier Walls	Slurry Walls	These subsurface barriers consist of vertically excavated trenches filled with a low permeable material. The material creates a hydraulic barrier to retard ground water flow.	Low	Medium	Low/Medium	Heavy construction required. Walls only contain groundwater and redirect flow; does not treat COCs. May extent plume laterally. Cost dependent on various factors.	Reject
	Interceptor Trench	Interceptor Trench	A vertical boundary of highly permeable material in which groundwater is pumped to creat a sump	Low	Medium	Medium	Heavy constructioin required. Does not treat COCs, would require ex-stiu treatment. Same effect can be achieved with well pumping	Reject
Extraction	Pumping	Pumping	Ground water pumping is a component of the pump-and-treat processes.	Medium	High	High	Does potentially reduce volume of contaminants within groundwater and retards contaminant mobility from site. Requires ex-situ treatment.	**Retain**
In-situ - Treatment	Chemical	Chemical Oxidation	Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic.	High	High	Medium	Does potentially reduce volume of COCs within groundwater. No ex-situ treatment required. Process can be implemented using simple and relatively available equipment.	**Retain**
		Reactive Treatment Walls	These barriers allow the passage of water while causing the degradation or removal of contaminants.	High	Medium	High	Heavy construction required. Does potentially reduce volume of COCs within groundwater. Hard to monitor fouling or COC breakthrough.	Reject
	Physical	Air Sparging	Air is injected into saturated matrices to remove contaminants through volatilization. SVE extracts vapors from soil.	Medium	Medium	Medium	Does potentially reduce volume of contaminants within groundwater. Requires vapor removal from soil and ex-situ treatment.	Reject
		In-well Air Stripping	Air injected into a well and VOCs are transferred to vapor by air bubbles.The air rises in the well to the water surface where vapors are drawn off and treated by a soil vapor extraction system.	Low	Low	Medium	Shallow aquifers may limit process effectiveness. Awareness of process is limited in United States	Reject
	Biological	Bioremediation	Introduction of substrates into the groundwater to promote microbe growth and subsequent destruction of COCs.	Medium	High	Medium	Does potentially reduce volume of COCs within groundwater. No ex-situ treatment required. Process can be implemented using simple and relatively available equipment.	**Retain**
Ex-situ Treatment	Chemical	Advanced Oxidation - UV, Ozone	Use agents to oxidize COCs from extracted groundwater	High	Medium	High	Process can be better controlled to more uniformly reduce contaminants. Requires site space for aboveground process. Effluent water will need to be dealt with. Energy requirements make costs higher than other technologies.	Reject
	Physical	Air Stripping	COCs volatilized to vapor state by cascading or spraying groundwater.	High	High	Medium	Proven technology widely used for site's COCs. Effluent water needs to be dealt with. Creates vapor phase contaminants that may need further treatment.	**Retain**
		Carbon Absorption	Extract contaminants are filtered through carbon. Contaminants sorb onto carbon.	Medium	High	High	Carbon is less effective on low molecular compounds, such as vinyl chloride. Effluent water needs to be dealt with. Carbon will have to be disposed of or regenarated periodically. Spent carbon may be considered hazardous depending on contaminant concentrations sorbed	Reject
		Separation	Removal of water in media.	Medium	High	Medium	Requires site space for aboveground process. The presence of oil and grease contaminants (TPH) may interfere with these processes by decreasing flow rate.	Reject
	Thermal	Flare System	Combustion of COCs in a controlled environment	High	High	Medium	Would require pretreatment so contaminants can be addressed in vapor phase. Requires additional space on site. Would require fuel source.	**Retain**
		Thermal Oxidation	Destroy contaminants at high temperatures with the use of a catalyst to achieve a high degree of COC destruction.	High	High	High	Would require pretreatment so contaminants can be addressed in vapor phase. Requires additional space on site. Would require fuel source. Requires catalyst; The presence of chlorinated hydrocarbons and some heavy metals may poison a particular catalyst.	Reject
	Biological	Bioreactors	Contaminants in extracted groundwater are put into contact with microorganisms in attached or suspended growth biological reactors	Medium	High	Medium	Bioreactors are sensitive to flucuations in contaminant levels. Sludge and effluent water must be dealt with. Nuisance odors may be a problem. Requires site space for aboveground process.	Reject
Disposal - Groundwater	Injection to subsurface	Injection to subsurface	Discharge effulent water from ex-situ treatment back to groundwater regime.	High	Low	Medium	Requires additional wells in order to inject remediated water back to subsurface. May require groundwater injection permit.	Reject
	Discharge to Storm Sewer	Discharge to Storm Sewer	Discharge effulent water from ex-situ treatment to existing stormwater conveyance system	High	Medium	Low	Site has an existing stormwater system that could be tied into. Would require a discharge permit.	Reject
	Discharge to WWTP	Discharge to WWTP	Discharge effulent water to wastewater treatment plant servicing Fort Story.	High	Medium	Medium	POTW could handle small flows of remediated water. Sanitary system exists on site. Agreement with POTW may be required.	**Retain**

TABLE 5-1
INDIVIDUAL EVALUATION OF FINAL ALTERNATIVES
LARC 60 Maintenance Area
Fort Story

Criteria	**Alternative 1** **No Further Action**	**Alternative 2** **In Situ Chemical Oxidation**	**Alternative 3** **In Situ Bioremediation**	**Alternative 4** **Pumping w/ Air Stripping and Flare System**
Protection of Human Health and the Environment	No reduction in risk.	Expected to provide protection of human health by reducing risks. No risks to the environment.	Expected to provide protection of human health by reducing risks. No risks to the environment.	Expected to provide protection of human health by reducing risks. No risks to the environment.
Compliance with ARARs	Both State and Federal groundwater ARARs (e.g. MCLs) are not meet	Chemical specific ARARs are met for groundwater. Action-specific ARARS include compliance with OSHA requirements during construction and remedial action. No location specific ARARs.	Chemical specific ARARs are met for groundwater. Action-specific ARARS include compliance with OSHA requirements during construction and remedial action. No location specific ARARs.	Chemical specific ARARs are met for groundwater. Action-specific ARARS include compliance with OSHA requirements during construction and remedial action, compliance with air pollution and water quality regulations. No location specific ARARs.
Long-Term Effectiveness	No reduction in risk.	Expected to be effective in reducing or eliminating COCs in groundwater, thus reducing human health risks.	Expected to be effective in reducing or eliminating COCs in groundwater, thus reducing human health risks.	Expected to be effective in reducing or eliminating COCs in groundwater, thus reducing human health risks.
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility, or volume of contaminated groundwater	Toxicity, mobility, and volume of contaminated groundwater are reduced.	Toxicity, mobility, and volume of contaminated groundwater are reduced.	Toxicity, mobility, and volume of contaminated groundwater are reduced.
Short-Term Effectiveness	No action taken, therefore no short-term risks	Short-term risks identified for this alternative include construction safety during drilling operations and safety in handling oxidant addition.	Short-term risks identified for this alternative include construction safety during drilling operations.	Short-term risks involved with implementation of this alternative include traffic and noise problems for Site workers; drilling, excavation, and building construction hazards for contractor.
Implementability	Fully and easily implementable since there are no corrrective action components.	This alternative would be technically and administratively feasible to implement.	This alternative would be technically and administratively feasible to implement.	This alternative would be technically and administratively feasible to implement, but coordination will be required to avoid conflicts with Site mission.
COSTS (rounded to the nearest $1K)				
Capital Cost	$0	$447,000	$496,000	$548,000
First Annual O&M Cost	$0	$96,000	$99,000	$46,000
Present Worth Cost	$0	$631,000	$864,000	$1,009,000

FIGURE 1–2



MALCOLM PIRNIE

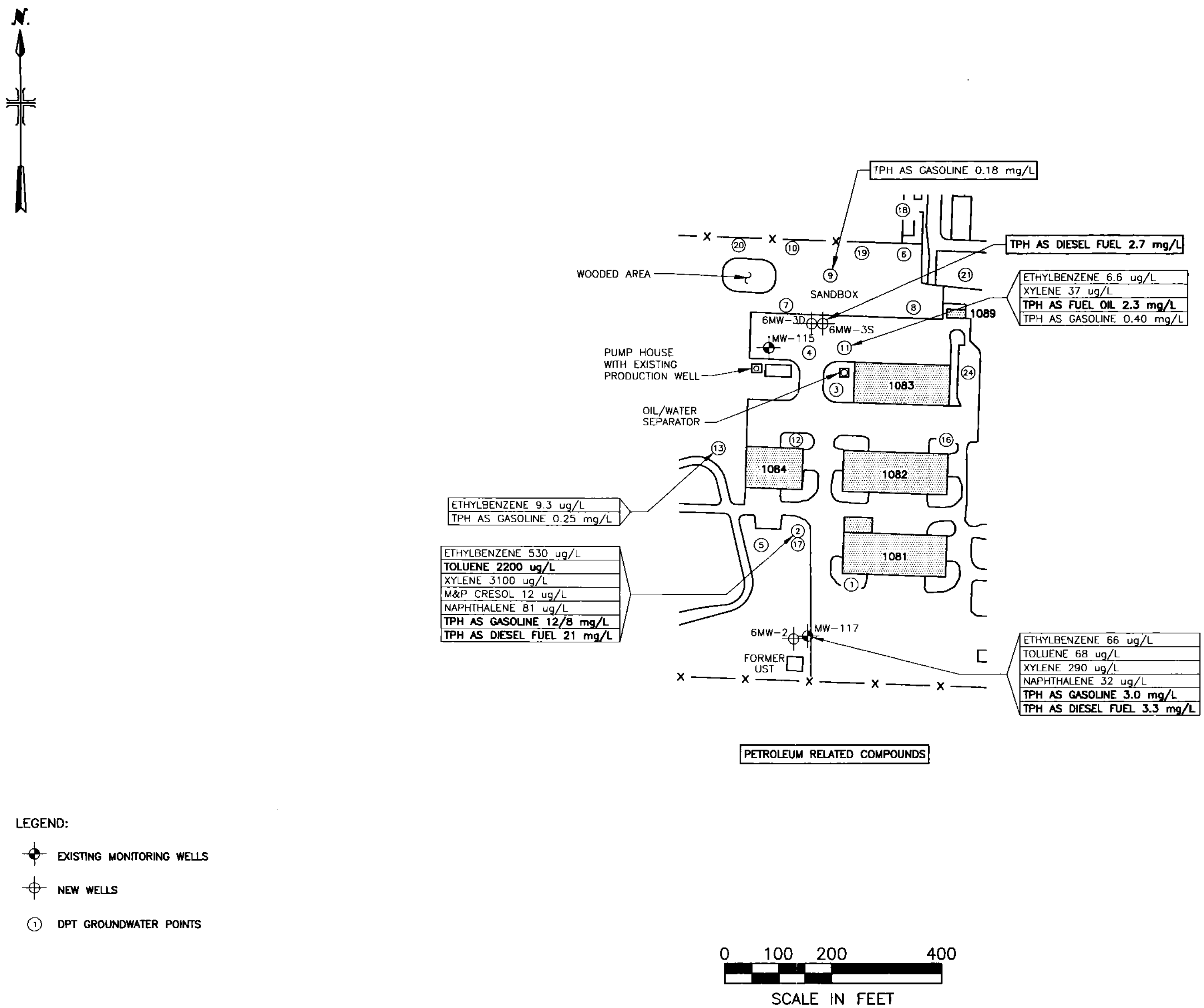
FORT STORY, VIRGINIA
FEASIBILITY STUDY
LARC 60 SOIL, SEDIMENT AND SURFACE WATER CONCENTRATIONS ABOVE EPA SCREENING CRITERIA

MALCOLM PIRNIE, INC.

DEC 2004

User:DARNELL Spec:PIRNIE STANDARD File:L:\0285 – US Army Corps of Engineers\589 – Ft Story LARC RI\Cadd\April 2002\FIG1-3.DWG Scale:1:1 Date:08/26/2002 Time:13:06 Layout:Layout1

FIGURE 1–3



MALCOLM PIRNIE

FORT STORY, VIRGINIA

FEASIBILITY STUDY

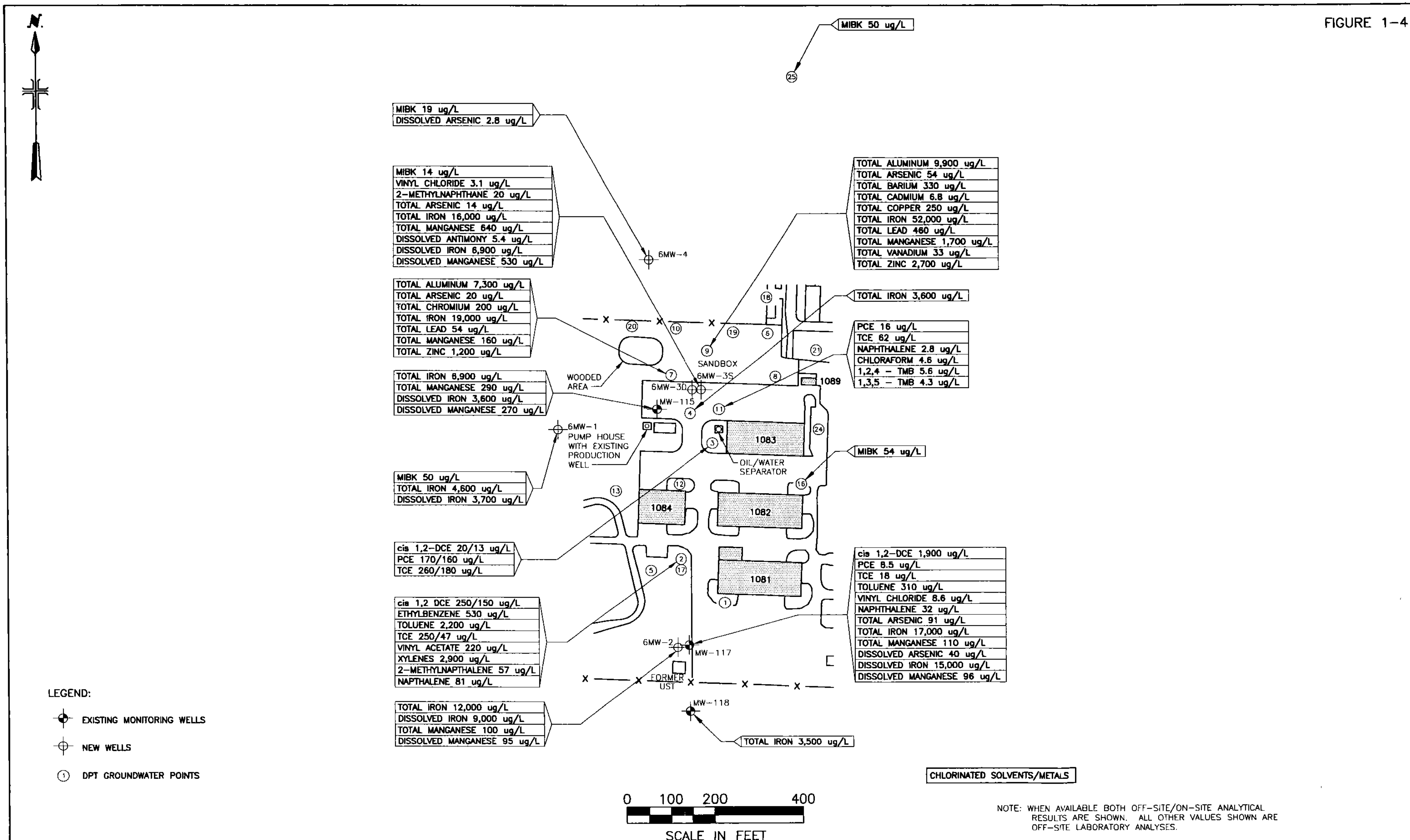
LARC 60 GROUNDWATER CONCENTRATIONS ABOVE EPA SCREENING CRITERIA

MALCOLM PIRNIE, INC.

DEC 2004

User:DARNELL Spec:PIRNIE STANDARD? File:L:\0285 - US Army Corps of Engineers\783 - Ft Story HTRW\Cadd\Feasibility Study\FIG1-4.DWG Scale:1:1 Date:11/30/2004 Time:10:07 Layout:Layout1

FIGURE 1-4



NOTE: WHEN AVAILABLE BOTH OFF-SITE/ON-SITE ANALYTICAL RESULTS ARE SHOWN. ALL OTHER VALUES SHOWN ARE OFF-SITE LABORATORY ANALYSES.

MALCOLM PIRNIE	FORT STORY, VIRGINIA FEASIBILITY STUDY LARC 60 GROUNDWATER CONCENTRATIONS ABOVE EPA SCREENING CRITERIA	MALCOLM PIRNIE, INC. DEC 2004

XREFS: IMAGES:None

TABLE 6
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Well ID and Results																RBCs (1)
	6MW-1				6MW-2				6MW-3S				6MW-3D				
	1995	2000	2003	2004	1995	2000	2003	2004	1995	2000	2003	2004	1995	2000	2003	2004	
Acetone	5 U	5 U	NT	NT	5 U	NT	NT	**270 D**	5 U	5 U	5 U	**17 J**	5 U	NT	5 U	**3.3**	550
Benzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	**0.6 J**	0.5 U	5 U	NT	5 U	0.5 U	0.34
Bromodichloromethane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.17
2-Butanone (MEK)	5 U	5 U	NT	NT	5 U	NT	NT	**21**	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	**2.5**	700
Carbon disulfide	5 U	5 U	NT	NT	5 U	NT	NT	**0.83**	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	100
Chloroform	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.15
Chloromethane	5 U	5 U	NT	NT	5 U	NT	NT	**0.23 JB**	5 U	5 U	5 U	**0.84 J**	5 U	NT	5 U	**0.21 J**	19
Cyclohexane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	---
Dibromochloromethane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.13
1,2-Dichlorobenzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	27
1,1-DCA	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	80
1,1-DCE	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	**1.3 J**	5 U	NT	5 U	0.5 U	35
cis 1,2-DCE	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	**2 J**	**1 J**	**100**	5 U	NT	5 U	**0.33 J**	6.1
trans 1,2-DCE	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	**0.87 J**	5 U	NT	5 U	0.5 U	12
Ethylbenzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	130
Isopropyl benzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	---
Methylcyclohexane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	630
Methylene chloride	5 U	5 U	NT	NT	5 U	NT	NT	**0.52 B**	5 U	5 U	5 U	**3.3 JB**	5 U	NT	5 U	**0.47 JB**	4.1
MIBK	5 U	**50**	NT	NT	5 U	NT	NT	2.5 U	5 U	**44**	13 U	2.5 U	5 U	NT	13 U	2.5 U	630
Styrene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	160
Tetrachloroethene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	**0.4 J**	**62**	5 U	NT	5 U	0.5 U	0.1
Toluene	5 U	5 U	NT	NT	5 U	NT	NT	**0.29**	5 U	5 U	**0.8 J**	0.5 U	5 U	NT	**0.9 JB**	**0.42 J**	75
1,2,4-Trichlorbenzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.72
Trichloroethene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 u	**1.3 J**	**1 J**	**140**	5 U	NT	5 U	0.5 U	0.026
Vinyl chloride	5 U	10 U	NT	NT	10 U	NT	NT	0.5 U	10 U	**3.1 J**	**1 J**	**9.7**	10 U	NT	5 U	**0.2 J**	0.015
Xylenes	5 U	10 U	NT	NT	5 U	NT	NT	1 U	5 U	10 U	5 U	1 U	5 U	NT	5 U	1 U	21

Notes:

(1) EPA Region III Risk-based Concentration Criteria for Tap Water

NT - Not tested

J - Estimated concentration (result between MDL and PQL for organics)

B - Detected in associated method blank

Organics detected are bolded and italicized.

Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

TABLE 6
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	6MW-4				6MW-5S		6MW-5D		6MW-6		6MW-7		6MW-8		6MW-9		RBCs (1)
	1995	2000	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	
Acetone	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	550
Benzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	**0.2 J**	0.5 U	0.34
Bromodichloromethane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.83**	5 U	0.5 U	5 U	0.5 U	0.17
2-Butanone (MEK)	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0. 5U	5 U	0. 5U	5 U	0. 5U	700
Carbon disulfide	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	100
Chloroform	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**3.3**	5 U	0.5 U	5 U	0.5 U	0.15
Chloromethane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.18 J**	19
Cyclohexane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	---
Dibromochloromethane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.12 J**	5 U	0.5 U	5 U	0.5 U	0.13
1,2-Dichlorobenzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	27
1,1-DCA	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	80
1,1-DCE	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	35
cis 1,2-DCE	5 U	5 U	5 U	NT	5 U	**1.1**	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.15 J**	5 U	0.5 U	6.1
trans 1,2-DCE	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	12
Ethylbenzene	5 U	5 U	5 U	NT	5 U	0. 5U	5 U	0.5 U	5 U	0. 5U	5 U	0. 5U	5 U	0. 5U	5 U	0.5 U	130
Isopropyl benzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	---
Methylcyclohexane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	630
Methylene chloride	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	**0.2 J**	5 U	**0.15 J**	5 U	**0.14 J**	5 U	**0.44 JB**	4.1
MIBK	5 U	**19**	13 U	NT	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	630
Styrene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	160
Tetrachloroethene	5 U	5 U	5 U	NT	5 U	**0.84**	5 U	0.5 U	5 U	0.5 U	**11**	**0.49 J**	5 U	0.5 U	5 U	0.5 U	0.1
Toluene	5 U	5 U	**0.6 J**	NT	**1 JB**	0.5 U	**1 JB**	0.5 U	**1 JB**	0.5 U	**1 JB**	**0.1 J**	**0.7 J**	0.5 U	**0.5 JB**	**0.15 J**	75
1,2,4-Trichlorbenzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	0.72
Trichloroethene	5 U	5 U	5 U	NT	5 U	**1.7**	5 U	**0.10 JB**	5 U	0.5 U	5 U	0.5 U	**0.5 J**	**0.15 J**	5 U	0.5 U	0.026
Vinyl chloride	10 U	10 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	0.015
Xylenes	10 U	10 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	21

Notes:

(1) EPA Region III Risk-based Concentration Criteria for Tap Water

NT - Not tested

J - Estimated concentration (result between MDL and PQL for organics)

B - Detected in associated method blank

Organics detected are bolded and italicized.

Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

TABLE 6
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

	6MW-10	6MW-11	MW-115				MW-117				MW-118				
Parameters	**2004**	**2004**	**1995**	**2000**	**2003**	**2004**	**1995**	**2000**	**2003**	**2004**	**1995**	**2000**	**2003**	**2004**	**RBCs (1)**
Acetone	**5.5**	0.5 U	5 U	5 U	5 U	**2.9**	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**3**	550
Benzene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.34
Bromodichloromethane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.17
2-Butanone (MEK)	**4**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**1.5 J**	700
Carbon disulfide	**0.22 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	100
Chloroform	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.15
Chloromethane	**0.31 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**0.26 J**	19
Cyclohexane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**2.7**	5 U	5 U	5 U	0.5 U	---
Dibromochloromethane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.13
1,2-Dichlorobenzene	0.5 U	0.5 U	5 U5	5 U	5 U	**0.16 J**	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	27
1,1-DCA	0.5 U	0.5 U	5 U	5 U	5 U	**0.34 J**	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	80
1,1-DCE	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	35
cis 1,2-DCE	0.5 U	0.5 U	5 U	5 U	5 U	**0.3 J**	**20**	**1,900**	**22**	**24**	5 U	5 U	5 U	0.5 U	6.1
trans 1,2-DCE	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**0.25 J**	5 U	5 U	5 U	0.5 U	12
Ethylbenzene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	**66**	**76**	**29**	**6.8**	5 U	5 U	5 U	0.5 U	130
Isopropyl benzene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**6.2**	5 U	5 U	5 U	0.5 U	---
Methylcyclohexane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**16**	5 U	5 U	5 U	0.5 U	630
Methylene chloride	**0.45 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**0.43 JB**	4.1
MIBK	2.5 U	0.5 U	5 U	13 U	13 U	2.5 U	5 U	250 U	13 U	**4**	5 U	5 U	13 U	2.5 U	630
Styrene	**0.12 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	50 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	160
Tetrachloroethene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	**8.5**	50 U	**2 J**	**0.67 J**	5 U	5 U	5 U	0.5 U	0.1
Toluene	**0.36 J**	**0.17 J**	5 U	5 U	**0.7 J**	0.5 U	**68**	**310**	**1 JB**	**0.15 J**	5 U	5 U	**1 JB**	**0.27 J**	75
1,2,4-Trichlorbenzene	**0.15 JB**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	50 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.72
Trichloroethene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	**18**	50 U	**1 J**	0.5 U	5 U	5 U	5 U	0.5 U	0.026
Vinyl chloride	0.5 U	0.5 U	10 U	10 U	5 U	0.5 U	10 U	**8.6 J**	5 U	0.5 U	10 U	10 U	5 U	0.5 U	0.015
Xylenes	0.5 U	0.5 U	5 U	10 U	5 U	0.5 U	**290**	**450**	**130**	**65**	5 U	10 U	5 U	0.5 U	21

Notes:

(1) EPA Region III Risk-based Concentration Criteria for Tap Water

NT - Not tested

J - Estimated concentration (result between MDL and PQL for organics)

B - Detected in associated method blank

Organics detected are bolded and italicized.

Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

DRAFT

FEASIBILITY STUDY REPORT

LARC 60 MAINTENANCE AREA
FORT STORY, VIRGINIA

PREPARED FOR:

U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
BALTIMORE, MARYLAND

AND

U.S. ARMY TRANSPORTATION CENTER
FORT EUSTIS, VIRGINIA

CONTRACT DACA31-94-D-0017
DELIVERY ORDER NO. 167

MARCH 2005

MALCOLM PIRNIE, INC.
701 Town Center Drive, Suite 600
Newport News, Virginia 23606

0285-783

TABLE OF CONTENTS

DRAFT
Feasibility Study Report

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ES.1 INTRODUCTION

Malcolm Pirnie, Inc. was contracted by the U.S. Army Corps of Engineers (USACE), Baltimore District to conduct a Feasibility Study (FS) at the LARC 60 Maintenance Area at Fort Story, Virginia under Contract DACA31-94-D-0017, Delivery Order No. 167. The Remedial Investigation (RI) Report recommended an FS to evaluate remedial alternatives for remediation of groundwater contaminated with chlorinated solvents.

Purpose

The purpose of the FS was to develop, screen, and evaluate remedial alternatives that are protective of human health and the environment and that are potentially capable of meeting requirements proposed by state and federal regulatory agencies. Specific objectives included the following:

- Development and screening of remedial alternatives through the following process:
  - Identification of remedial action objectives.
  - Identification of potential treatment, resource recovery, and containment technologies that will satisfy the remedial action objectives.
  - Screening of technologies based on effectiveness, implementability, and cost.
  - Assembling of technologies into alternatives.
- Detailed evaluation of alternatives with respect to nine criteria as developed by EPA to address the statutory requirements and preferences of CERCLA.

Site Description and History

The Lighterage Amphibious Resupply Cargo (LARC) 60 Maintenance Area, which is the maintenance and wash rack area for LARC 60 vehicles, is located in the sand flat area of Fort Story between the coastal dune complex to the north and the central sand ridge to the south. A former 10,000-gallon underground storage tank (UST) was located at the north gate of the LARC 60 vehicle motor pool approximately 600 feet south of the wash rack area. This UST was installed in 1983 and used for waste oil and degreaser storage. Although James M. Montgomery, Inc.'s (JMM) April 1990 field visits to this area identified soil-stained zones around the UST, there are no reports of tanks failing or leaking documented. These soil-stained areas may have been caused by overfilling or spillage during use. In 1987, the U.S. Army Environmental Hygiene Agency sampled the UST and found it contained oil, water, 1,1,1-trichloroethane and chromium.

Previous Investigations

A summary of previous investigations conducted at this site is provided in the table below.

PREVIOUS INVESTIGATIONS		
Investigation	**Description**	**Results**
U.S. Army Environmental Hygiene Agency June 1987	Health risk assessment of soil contamination.	No unacceptable human health threat exists to workers at the site.
James M. Montgomery January 1992	Preliminary Assessment/Site Investigation conducted to determine presence of significant contamination at site.	Total petroleum hydrocarbons (TPH) and metals detected in soils. TPH and VOCs detected in groundwater.
IT Corporation November 1994	Removal action conducted to remediate soils.	Disposed of soils containing F-listed solvents offsite. Treated TPH contaminated soils on site via bioremediation.
Environmental Technology February 1995	UST investigation. Soil and groundwater samples were collected.	Numerous VOCs and TPH were detected in groundwater.
Malcolm Pirnie, Inc. May 2002	Remedial Investigation.	Chlorinated VOCs detected in site groundwater at levels creating unacceptable risk to human health.

In the Remedial Investigation Report (RI), a feasibility study (FS) was recommended for the LARC 60 Maintenance Area based on the results of the risk assessment that indicated potential risks for the following populations:

- Potential future residential populations exposed to groundwater via ingestion, inhalation, and/or dermal contact. The site is currently an industrial area. These exposure scenarios assume that housing would be developed in this area.

Thus, consideration of potential risks to human health at the site indicate that remediation of the site may be prudent. No significant ecological risks are associated with the site.

This recommendation is based on the detection of concentrations of volatile organic compounds (VOCs), typically chlorinated solvents, and semi-volatile organic compounds (SVOCs) in groundwater. The FS will evaluate and identify remedial technologies and alternatives to remediate groundwater; however, risks associated with inorganic constituents are to be managed and are not addressed as part of the remediation.

ES.2 Remedial Action Objectives

The remedial action objectives (RAOs) described in this section were developed for the site based on the findings of the human health and ecological risk assessments presented in the Remedial Investigation (RI) Report, and will be used as the basis to select the most cost effective remedial action for the site. RAOs are site-specific, initial clean-up objectives that are established on the basis of the nature and extent of contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure.

The RAOs for the remediation of impacted groundwater include the following:

- Prevent present human consumption and inhalation of contaminated groundwater that would result in a total site cancer risk in excess of 10^{-6} (1 in one million) and a non-cancer risk where the hazard index is greater than 1.

- Assuming residential housing is developed in the area, reduce potential health impacts to potential future adult and child residential populations from ingestion of groundwater and inhalation of the groundwater's volatile constituents.

- Remediate groundwater to meet chemical specific ARARs as appropriate or to an acceptable level of risk if no chemical specific ARARs exist.

Remediation Goals

Preliminary remediation goals will be determined on the basis of the results of the baseline risk assessment and the evaluation of the expected exposures following remedial action. Remediation goals will be evaluated on the following factors:

- Provides protection from carcinogens within the risk range of 10^{-4} to 10^{-6}.
- Provide protection for non-carcinogens such that the hazard index is not greater than 1.
- Adequately addresses each significant pathway of exposure (groundwater ingestion and inhalation for this site).

In order to meet the general goals cited above, Preliminary Remediation Goals (PRGs) have been calculated and/or established for the site. The PRGs focused upon the organic constituents (i.e., VOCs and SVOCs) as the RI Report indicates that these are the primary constituents of concern (i.e., the largest contributors of site risk). As such, PRGs are presented in **Tables 2-3**.

The calculation of the human health PRGs were based on maximum contaminant levels (MCLs) or on a child exposure since they have the greatest exposure risks to groundwater as documented in the RI Report. The use of the child exposure is the most conservative and will also be protective for future residential adults. These human health PRGs were developed for the potable use of groundwater by potential, future residents. No ecological PRGs were established, since no significant risk to ecological receptors was identified in the RI Report.

Area of Affected Media

COCs were detected in varying concentrations throughout the site, therefore the contamination will be addressed on a site-wide basis.

ES.3 DEVELOPMENT OF REMEDIAL ALTERNATIVES

The objective of developing alternatives is to assemble the process options and technologies that were retained during screening into remedial action alternatives. The alternatives should be protective of human health and the environment and provide several remedial options.

Remedial alternatives have been developed in an effort to represent the most feasible range of remedial actions in terms of both cost-effectiveness in protection of human health and the environment and of level of difficulty in implementation. These alternatives have been developed to meet the Remedial Action Objectives, which focus on preventing human exposure to VOCs and SVOCs in groundwater.

The process options retained in the screening process are listed in Section 3.3. Due to the limited quantity of appropriate technologies, a limited number of remedial alternatives were developed. Since a limited number of remedial alternatives were developed, the initial screening of remedial alternatives will be eliminated and the detailed analyses will be performed. Although not to be discussed for each alternative, monitoring of groundwater accompanies each of the below listed alternatives and is recommended for implementation regardless of which alternative is ultimately selected. The alternatives are provided below.

- **Alternative 1** - ***No Action***
- **Alternative 2** – ***In Situ Chemical Oxidation Of Groundwater Contamination***
- **Alternative 3** – ***In Situ Bioremediation of Groundwater Contamination***
- **Alternative 4** – ***Groundwater Pumping to Ex Situ Air Stripping with a Flare System for Off-Gas Destruction***

ES.4 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

The remedial alternatives were evaluated in relation to one another for the first seven of the following nine criteria:

- Protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

State and community acceptance will be addressed as part of the Record of Decision (ROD). The purpose of this analysis was to identify the relative advantages and disadvantages of each alternative. A summary of the analysis is provided below.

Alternatives 2 and 3 appear to be the most feasible and cost effective alternatives for remediating the Site. While Alternative 4 meets the criteria, it is less preferable as it requires handling of contaminated groundwater and discharge of vapor and liquid effluents. Alternative 1 does not meet the threshold criteria, and therefore, cannot be selected. Since Alternative 2 is relatively less expensive and quicker than Alternative 3, Alternative 2 is the preferred alternative.

INTRODUCTION

Malcolm Pirnie, Inc. was contracted by the U.S. Army Corps of Engineers (USACE), Baltimore District to conduct a Feasibility Study (FS) at the LARC 60 Maintenance Area at Fort Story, Virginia under Contract DACA31-94-D-0017, Delivery Order No. 167. The Remedial Investigation (RI) Report recommended an FS to evaluate remedial alternatives for remediation of groundwater contaminated with chlorinated volatile organic compounds (VOCs) underlying the LARC 60 Maintenance Facility.

The FS will be conducted in accordance with the U.S. Environmental Protection Agency (USEPA) guidelines contained in "Guidance on Remedial Investigations and Feasibility Studies under CERCLA", USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9335.3-01, dated March 1988 and the contents of 40 CFR 300, National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan, NCP).

1.1 PURPOSE

The purpose of the FS is to develop, screen, and evaluate remedial alternatives that are protective of human health and the environment and that are potentially capable of meeting requirements proposed by state and federal regulatory agencies. Specific objectives include the following:

- Development and screening of remedial alternatives through the following process:
  - Identification of remedial action objectives.
  - Identification of potential treatment, resource recovery, and containment technologies that will satisfy the remedial action objectives.
  - Screening of technologies based on effectiveness, implementability, and cost.
  - Assembling of technologies into alternatives.

- Detailed evaluation of alternatives with respect to nine criteria as developed by USEPA to address the statutory requirements and preferences of CERCLA.

The scope of this FS addresses those actions necessary to reduce risks to human health and the environment as identified and determined to be unacceptable in the RI Report. Unacceptable risk are those identified to be in excess of criteria established in the USEPA document *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)*, USEPA 1989, and, *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual*, USEPA, 1989. In addition, this FS addresses only those media that cause or contribute to the unacceptable level of risk. Unacceptable risks, which constitute the rationale for remedial action, are discussed for the site in detail in Section 1.3.2.4.

Remedial alternatives will be evaluated according to nine criteria specified in the NCP, 40 CFR 300.430 (e)(9)(iii). These nine criteria include the following:

- Overall protection of human health and the environment
- Overall compliance with ARARs
- Long-term effectiveness and permanence
- Reduction in toxicity, mobility or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- Community acceptance
- State acceptance

1.2 REPORT ORGANIZATION

Section 1.0 of this report presents an introduction to the FS to include its purpose, the report organization format, and a summary of background information (e.g., site description and results of the RI).

Section 2.0 of this report presents the remedial action objectives (RAOs), preliminary remediation goals, and ARARs.

Section 3.0 of this report presents the general response actions, and the identification and screening of remedial technologies and process options.

Section 4.0 of this report presents the development and screening of remedial alternatives based on the assembling of technologies screened in Section 3.0.

Section 5.0 provides a detailed analysis of remedial alternatives as compared to the nine criteria.

Section 6.0 provides a comparative analysis of the alternatives.

1.3 BACKGROUND

1.3.1 Site Description and History

The Lighterage Amphibious Resupply Cargo (LARC) 60 Maintenance Area, which is the maintenance and wash rack area for LARC 60 vehicles, is located in the sand flat area that lies between the coastal dune complex to the north and the central sand ridge to the south. The LARC 60 area includes Buildings 1081, 1082, 1083 and 1084. The location of the site is presented in **Figure 1-1**.

During the 1950s, the wash rack area was first used as the barge amphibious resupply cargo (BARC) motor pool and maintenance facility. In 1964, the BARC vehicle was phased out and the LARC 60 vehicle was prototyped. Presently, Fort Story is the only base on the East Coast available to the Army Transportation Corps for amphibious training.

In 1982, the LARC 60 facility was modified with the construction of a concrete wash rack pad. Approximately 39 catch basins are located through the LARC 60 site, which are used for collection of storm and wash water. Heavy equipment is currently stored awaiting maintenance and operated on the concrete wash rack and Sandbox Area.

A former 10,000-gallon underground storage tank (UST) was located at the north gate of the LARC 60 vehicle motor pool approximately 600 feet south of the wash rack area. This UST was installed in 1983 and used for waste oil and degreaser storage. Although James M. Montgomery, Inc.'s (JMM) April 1990 field visits to this area identified soil-stained zones around the UST, there are no reports of tanks failing or leaking documented. These soil-stained areas may have been caused by overfilling or spillage during use. In 1987, the U.S. Army Environmental Hygiene Agency sampled the UST and found it contained oil, water, 1,1,1-trichloroethane and chromium.

1.3.2 Previous Investigations

A summary of previous investigations conducted at this site is provided in the table below.

PREVIOUS INVESTIGATIONS		
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Malcolm Pirnie, Inc. May 2002	Remedial Investigation.	Chlorinated VOCs detected in site groundwater at levels creating unacceptable risk to human health.

1.3.2.1 U.S. Army Environmental Hygiene Agency Risk Assessment

The U.S. Army Environmental Hygiene Agency (USAEHA) conducted a Health Risk Assessment in June 1987 at the LARC 60 Maintenance Area to determine if an unacceptable health threat exists to workers at the site. USAEHA detected grease, oil, lead and chromium in soil north of the wash rack (Sandbox Area). For the contaminants, the excess, upper bound, lifetime cancer risk estimate calculated was within the range considered acceptable to the USEPA. In addition, the hazard index derived was less than one, indicating that non-carcinogenic health effects would not be expected. Based on the quantitative risk assessment, USAEHA concluded that an unacceptable human health threat does not exist to workers at the site.

1.3.2.2 James M. Montgomery, Inc. (JMM) Preliminary Assessment/Site Investigation

Preliminary assessment/site investigation (PA/SI) activities were conducted in 1991 and 1992 by James M. Montgomery, Inc. (JMM, 1992). JMM conducted the PA/SI to determine the presence of significant contamination at eight sites including the LARC 60 Maintenance Area.

At the facility, several analytes were detected in soil at levels above the trigger levels. The site has two main areas of possible environmental concern: the wash rack area, which has an oil/water separator, and the former UST area. Total fuel hydrocarbons, copper, zinc, and lead were detected above trigger levels at the site.

As with soil samples, numerous analytes were detected in groundwater above trigger levels at the wash rack and UST areas. Benzene, vinyl chloride, total fuel hydrocarbons, and 1,1-DCE were detected above trigger levels.

A remedial investigation/feasibility study (RI/FS) was recommended at the LARC 60 Maintenance Area and three other sites.

1.3.2.3 IT Corporation Removal Action

IT Corporation (IT, 1994) conducted several rapid response removal actions at Fort Story in 1994, including the LARC 60 Maintenance Area. IT Corporation reported that the following activities were performed at the site:

- Disposal off-site of two piles of soil believed to contain F-listed solvents.
- Designed and installed an in situ bioremediation system for the treatment of TPH-contaminated soils.
- Excavated and treated soil within the LARC 60 Sandbox to a TPH level of less than 50 parts per million (ppm). The soils were transferred to the bioremediation system for treatment.
- Placed remediated soils back in the excavated area. However, due to the presence of heavy oils and greases in the soils, the 50 ppm treatment goal could not be reached with the bioremediation process. TPH concentrations remaining in treated soils ranged from non-detect to 4,800 ppm with an average concentration of 229 ppm (by Method 8015) and 751 ppm (by USEPA Method 418.1) remaining in soils.

1.3.2.4 Environmental Technology of North America, Inc., UST Investigation

In February 1995, Environmental Technology of North America, Inc. (ETI) through a USACE, Norfolk District contract, collected soil and groundwater samples by direct push technology (DPT) from the former UST pit at the southern end of the site to determine groundwater quality in that location. TPH, toluene, ethylbenzene and xylene were detected in soils from the pit and from stockpiled soils. Numerous chlorinated organics were detected in the groundwater sample including TPH (180 mg/l), tetrachloroethene (2,700 *ug/l*), trichloroethene (8,800 *ug/l*), and cis 1,2-dichloroethene (5,200 *ug/l*).

1.3.2.5 Malcolm Pirnie Remedial Investigation

Malcolm Pirnie, Inc. prepared a Remedial Investigation Report (RI) for the LARC 60 Maintenance Area in May 2002. A summary of the nature and extent of contamination and the baseline risk assessment from the RI is provided below.

Nature and Extent of Contamination

There were three major areas of concern (AOCs) at the site: (1) Former UST Area, (2) Oil/Water Separator (OWS) Area, and (3) Sandbox Area. The layout for the sampling points was centered around these three areas with upgradient, on-site and downgradient soil and groundwater sampling being conducted at each AOC. Sampling was conducted in two separate events, the first in the spring of 1995 and the second in spring of 2000.

For the 1995 samples, (1) all samples were analyzed for Target Compound List (TCL) VOCs and semivolatile organic compounds (SVOCs), and TPH Heavy and Light fractions and (2) Target Analyte List (TAL) metal analysis was conducted on all surface water and sediment samples and for approximately 20 percent of soil and groundwater samples because of their infrequent detection in previous investigations. For the 2000 samples, (1) four monitoring wells (4MW-1, MW-111, MW-112, and MW-114A) were sampled for the first time for pesticides and polychlorinated biphenyls (PCBs), (2) the same four wells were sampled for TCL VOCs and TAL metals (total and dissolved fractions), and (3) eight soil samples were analyzed for pesticides and PCBs.

A summary of investigation results is presented by media type below. Tables for the RI Report are presented in **Appendix A**.

<u>Soil</u>

The soil samples were collected to assess the lateral and vertical extent of contamination on the ground surface and in the vadose zone. Soil samples analyzed for TAL were distributed among upgradient, on-site and downgradient, and at various subsurface soil depths. Sampling locations with significant detections are presented on **Figure 1-2.**

Numerous VOCs and SVOCs (specifically polynuclear aromatic hydrocarbons (PAHs) and phthalates) were detected in surface and subsurface soils. Detections were made in all three AOCs. All detected compounds were below the USEPA risk-based concentrations (RBCs), typically several orders of magnitude below the RBCs.

TPH as Heavy Oils was detected in 31 of 49 samples at the site. Twenty-nine (29) of these samples had concentrations greater than the 100 *mg/kg* screening criteria. No other TPH compounds were detected in LARC 60 site soils.

Numerous metals were detected in surface and subsurface soils. Although some concentrations were greater than background levels, all detected concentrations of metals, except arsenic, were one order of magnitude lower than the USEPA risk screening criteria. Arsenic exceeded the USEPA RBC for residential soils in 3 soil samples.

No PCBs were detected in any of the eight soil samples collected throughout the site in 2000. Several pesticides were detected in surface soils. These concentrations are below USEPA RBCs for industrial and residential soils. Pesticide concentrations at this site are consistent with levels seen on military installations from widespread pesticide application, not from waste disposal or spills.

<u>Sediment</u>

Samples of sediment were collected from two locations in the drainage ditch north of the site. Sampling locations with significant detections are presented on **Figure 1-2**.

No VOCs or SVOCs were detected in the sediment samples collected at the site.

TPH as Heavy Oils was detected in both samples at concentrations greater than the 100 *mg/kg* screening criteria. No other TPH compounds were detected in the sediment.
Numerous metals were detected in the sediment. All metal concentrations detected were lower than the USEPA RBCs for industrial and residential soils.

<u>Surface Water</u>

The two surface water samples were co-located with the sediment samples. Sampling locations with significant detections are presented on **Figure 1-2**.

One VOC, Acetone, was detected in surface water. Acetone was detected in both samples, however the concentrations are below the USEPA RBC for tap water.

TPH and SVOCs were not detected in surface water.

Several metals were detected in the surface water samples. Only one metal, manganese, was detected above the USEPA RBC for tap water.

Groundwater

Groundwater samples were collected by a number of methods as listed below:

- A total of eight monitoring wells were sampled to assess the lateral and vertical extent of contamination in the Columbia Aquifer (water table aquifer). Six of the wells are screened as shallow as 2 to 12.5 feet below grade (6.95 to -3.05 feet mean sea level (MSL)) and two other wells (6MW-2 and 6MW-3D) are as deep as 30 to 40 feet below grade (-16.98 to -26.98 feet MSL).

- Three temporary well points installed at the Former UST Area were sampled to assess the nature of VOC and TPH contamination in groundwater and confirm the presence or absence of free floating product in the Former UST Area.

- Twenty-five (25) groundwater samples were collected from non-permanent sampling locations using a DPT rig to penetrate to desired sampling depths. Non-permanent DPT groundwater samples were collected in the three AOCs to assess the lateral and vertical extent of contamination in groundwater. One DPT point (GW06-17) was sampled at a depth of 39 to 40 feet to assess the vertical extent of contamination.

For those groundwater samples analyzed for TAL compounds, both total and dissolved fraction analyses were conducted. **Figures 1-3 and 1-4** show existing wells, new wells, and DPT points with corresponding groundwater sampling results for concentrations of significant detections of COCs at each location.

The lateral distribution of chlorinated hydrocarbons and petroleum hydrocarbons extended from the Former UST Area northeastward to the Sandbox Area. Several VOCs were detected at concentrations greater than the USEPA RBC Criteria in the Former UST Area. One sampling location (WP-1) within the former pit and five sampling locations downgradient of the Former UST Area contained VOCs including PCE and/or one or more of its degradation products (TCE and 1,2-DCE). Two of the four sampling locations (DPT #3 and DPT #11) were near the OWS approximately 500 feet downgradient of the Former UST Area.

The sampling locations with detections of VOCs including PCE and its degradation products are summarized below:

VOC	AOC No. 1 UST SAMPLE LOCATIONS				AOC No. 2 OWS SAMPLE LOCATIONS		USEPA RBC[3] CRITERIA *(ug/l)*
	MW-117 *(ug/l)*	DPT-2[2] *(ug/l)*	WP-1 *(ug/l)*	WP-2 *(ug/l)*	DPT-3 *(ug/l)*	DPT-11 *(ug/l)*	
PCE	8.5[1] / < 50	<50/25	370	13	170/160	12	1.1
TCE	18 / < 50	<50/47	1,300	36	260/180	62	1.6
Vinyl chloride	< 10 / 8.6	BDL	BDL	BDL	BDL	BDL	0.015
cis 1,2-DCE	20 / 1,900	<50/150	3,200	120	20/30	<5	6.1

Notes:
1. Underlined text exceeds the screening criteria.
2. Off-site analytical result/On-site analytical result.
1. USEPA Risk-based Criteria for Tap Water.
2. 1995 sample result / 2000 sample result

The former UST was used to store waste oil and waste chlorinated solvents (degreasers from maintenance shops), such as PCE. If the Former UST Area is assumed to be the source of the release of these compounds based on historical use of the former UST and the temporary well point (WP-1) groundwater data which shows elevated levels of VOCs especially chlorinated hydrocarbons in the pit area, then an apparent vertical and lateral distribution of PCE and degradation compounds can be discerned.

Based on the assumption that the Former UST Area was the source of the release, the lateral distribution of PCE, TCE, cis 1,2-DCE, and vinyl chloride implies these compounds have migrated with groundwater from the Former UST Area downgradient to the northeast. The observed distribution of PCE and degradation products implies that the plume has impacted groundwater downgradient from the Former UST Area at DPT #11 and as far downgradient as well 6MW-3S since TCE, cis 1,2-DCE, and vinyl chloride were detected in this well in the 2000 year sampling but not in the original 1995 sampling. VOCs are still present at well MW-117 based on the 2000 sampling data. Since PCE and its degradation products were not detected at DPT points #13 and #16 located west and east of the zone of impact, the lateral distribution of these compounds in groundwater is very narrow as delineated by the sampling program. The narrowness of the plume may be the result of the impact of subsurface structures such as utility lines, building footings, or sedimentary variations on groundwater flow and contaminant transport. This implies that the primary direction and method of transport is to the northeast as a dissolved phase in groundwater. Based on the previous discussion concerning the apparent absence of DNAPLs, PCE and its degradation products are present in a dissolved state and are migrating in groundwater along the primary groundwater flow direction toward the northeast.

The vertical extent of contamination was delineated by the sampling program. The DPT points and monitoring wells with detectable concentrations of PCE and its degradation products penetrated to a depth of approximately 14 feet below grade. Detectable concentrations of PCE or its degradation products were not present in groundwater samples from deeper wells indicating that in these areas the vertical extent of contamination is limited to depths above 30 feet. DPT #17, located downgradient of MW-117 and adjacent to DPT #2, penetrated to 39.5 feet for collection of groundwater samples. TCE and cis 1,2-DCE were detected in DPT #2 (terminated less than 14 below grade) but not in the deeper sample collected from DPT #17 indicating that in this area the vertical extent of contamination is limited to above 39.5 feet. However, since no deeper groundwater samples were collected in well 6MW-3D in the 2000 sampling event, it is unclear whether more extensive vertical migration is now occurring.

Several other VOCs were detected at levels less than the USEPA RBC Criteria and included ethylbenzene, xylene, and MIBK. Toluene was detected at WP-1 and DPT-2 at concentrations of 2,000 and 2,200 *ug/l*, respectively, which are an order of magnitude greater than its screening criteria of 750 *ug/l*. These VOCs along with the detected TPH compounds were used in assessing the presence and distribution of petroleum hydrocarbons.

Six (6) groundwater sampling locations had detections of TPH and petroleum aromatic hydrocarbons. Four (4) of the six (6) locations were downgradient of the OWS Area. No free floating product was observed in any well. A summary of these sampling results is presented below:

COMPOUND	UST SAMPLE LOCATIONS				OWS SAMPLE LOCATIONS				USEPA RBC(2) CRITERIA
	MW-117	DPT #2(1)	WP-1	WP-2	DPT #11	6MW-3S	DPT #9	DPT #13	
TPH as Gasoline (*mg/l*)	3.0	12/8	9.1	0.27	0.40	<0.05	0.18	<0.25	1.0(4)
TPH as Diesel Fuel (*mg/l*)	2.7	21	6.9	<0.30	<0.3	2.7	<3.0	<0.3	1.0(4)
TPH as Fuel Oil (*mg/l*)	<1.0	<20.0	BDL	BDL	2.3	<5.0	<1.0	<1.0	1.0(4)
Ethylbenzene (*ug/l*)	66 / 76	530	<5	<5	6.6	<5.0 / <10	<5	9.3	1,300
Naphthalene (*ug/l*)	32	81	NT	NT	< 10	<10	<10	< 10	6.5

COMPOUND	UST SAMPLE LOCATIONS				OWS SAMPLE LOCATIONS				USEPA RBC(2) CRITERIA
	MW-117	DPT #2(1)	WP-1	WP-2	DPT #11	6MW-3S	DPT #9	DPT #13	
Toluene (*ug/l*)	68 / 310	2,200	2,000	25	<5.0	<5.0 / <5	6.4	<5.0	750
Xylene (*ug/l*)	290 / 450	3,100	250	<5	37	<5.0 / < 10	<5	<5	12,000

Notes:
1. Off-site analytical result/On-site analytical result for DPT sample #2
2. USEPA Risk-based Criteria for Tap Water.
3. Underlined text exceeds the screening criteria.
4. Virginia Groundwater Standard for Petroleum Hydrocarbons.
5. 1995 sample result / 2000 sample result results reported for ethylbenzene, toluene, and xylene in MW-117 and 6MW-3S

The distribution of the above compounds is similar to that observed for PCE and its degradation products. Based on the Former UST Area being the source of the release of petroleum hydrocarbons to groundwater and including all sampling locations in the groundwater assessment, there is an apparent pattern in the distribution of the TPH compounds and PAHs. The highest concentrations of TPH (as Gasoline) and PAHs occur at DPT #2. The TPH and PAH concentrations decrease laterally from DPT #2 in the upgradient direction (at DPT #11 and DPT #9) and in the downgradient location (in well MW-117). Since DPT #9 and DPT #11 are downgradient of the OWS, the detected TPH compounds may be related to leakage from the OWS and/or migration from the Former UST Area or both. The detected TPH compounds in WP-1, which is located within the former UST pit, and WP-2 and MW-117, which are downgradient of the Former UST Area, appear to delineate the trailing edge of a plume migrating away from the Former UST Area. The TPH and PAH compounds were also detected at DPT #13 west of DPT #2 but not to the east at DPT #16. As noted for the PCE plume, the TPH and PAH plume is also narrow and migrating in the predominant groundwater flow direction toward the northeast.

With respect to the vertical extent of these compounds, the DPT points and wells MW-117 and 6MW-3S penetrated to a depth of approximately 14 feet. Only Wells 6MW-3D, 6MW-2, and DPT 17 extended to a depth of 30 to 40 feet below grade, but the samples from these wells and DPT point did not contain any detectable concentrations of the TPH or PAH compounds. As was the case for the PCE plume, the vertical extent of the distribution of TPH and PAHs is a minimum of 14 feet below grade but not to 30 feet below grade.

Although most of the analytical results correlate with the conceptual model for the plume, there are a few sampling locations with non-detects for TPH and PAHs that do not. First, none of the TPH or PAH compounds were detected in DPT #3 which is downgradient of DPT #2 and upgradient of the OWS. The sampling depth for DPT #2 of 13 feet below grade was deeper than that of DPT #3 at 9.5 feet below grade. The non-detects for TPH and PAH at DPT #3 may indicate that the detected compounds in DPT #11 (downgradient of DPT #3) may be related to the OWS and not to migration of a plume from the Former UST Area. DPT #1 and DPT #5 located east and west of the centerline of the area of impact penetrated to 13 and 9 feet below grade, respectively. Neither DPT sample contained detectable concentrations of TPH and PAHs. These two points are beyond the lateral area of impact. DPT #12 also did not contain detectable concentrations of TPH and PAH compounds. This location of DPT #12 may be impacted by groundwater flow influenced by subsurface features such as utility lines, building construction, or sedimentary variations.

As for SVOCs, Naphthalene was detected at MW-117 and DPT #2 at concentrations greater than the USEPA RBC for tap water. All other SVOCs detected were at concentrations two orders of magnitude less than the available screening criteria.

The concentration for total and dissolved arsenic, iron, and manganese exceeded the screening criteria at well MW-117 in the 1995 and 2000 sampling events. No other sampling locations in the Former UST Area detected concentrations of total or dissolved metals above the screening criteria. Near the OWS area, total arsenic was detected in well 6MW-3S in 1995 at a concentration of 14 *ug/l*, which is above the 0.045 *ug/l* USEPA RBC Criteria. However, arsenic was not detected in the dissolved metals analysis for 6MW-3S, which indicates that arsenic is not dissolved in groundwater at detectable concentrations. Thus, the total arsenic value is not representative of groundwater quality and is associated with the sediment in the groundwater sample. Neither total nor dissolved arsenic was detected in 6MW-3S during the 2000 sampling event. Various total and dissolved metals including antimony, iron, and manganese were detected through the OWS area above the USEPA RBC. In the Sandbox area, Total aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, vanadium, and zinc were detected in DPT samples at concentrations greater than the screening criteria. Since no dissolved metals analysis is available for the DPT samples, no conclusions can be made with regard to whether the detected concentrations are associated with sediments in the groundwater sample or in a dissolved state in groundwater.

Fate and Transport

The possible transport pathways identified for the LARC 60 Maintenance Area included the following:

- Volatilization of chlorinated hydrocarbons, PAHs and TPH as Gasoline from shallow groundwater to shallow soils.

- Volatilization of chlorinated hydrocarbons, PAHs and TPH as Gasoline from shallow soils to the atmosphere.

- Migration of TPH as Heavy Oils adsorbed to soil/sediments by storm runoff into the drainage ditch north of the Sandbox Area. Since there are no outlets from the drainage ditch, no subsequent sediment movement beyond the ditch is expected.

- Migration, enhanced by infiltrating rainwater, PAHs, and TPH as Gasoline, Diesel Fuel and Heavy Oils (to a lesser extent) through the vadose zone to groundwater.

- Migration of chlorinated hydrocarbons as advective flow, diffusion and dispersion in and along with groundwater.

- Adsorption of TPH as Gasoline, Diesel Fuel and Heavy Oils onto soil particles as a result of changes in the water table.

Soils and Sediments

TPH as Heavy Oils would be expected to be very persistent in the soil system due to their resistance to hydrolysis, oxidation and biodegradation. Also, due to its low vapor pressure, volatilization to the atmosphere would be a secondary pathway. Adsorption to the soil particles and within interstitial pores would be the predominant fate of these compounds. Some TPH as Heavy Oils would be expected to be transported along with the sediment to which it is adsorbed. This is probably occurring via stormwater runoff as well as by runoff during equipment maintenance activities at the wash rack immediately north of the OWS. The fate of this runoff is typically the drainage ditch. During dry periods, any TPH as Heavy Oils transported to the drainage ditch would be adsorbed to soil/sediment in the ditch.

Methylene chloride was detected in numerous soil samples with concentrations above the USEPA soil screening levels for transfer from soils to groundwater. The majority of the methylene chloride was detected in subsurface soils rather than in surface soils indicating the volatilization and leaching has impacted the surface concentration of methylene chloride. The majority of the subsurface soil samples were collected at a depth of 4 to 5 feet below land surface, which is the water table interface. However, even with the methylene chloride detected in this zone, methylene chloride was detected (below the quantitation limit) in only one groundwater sample indicating the it has not significantly impacted groundwater quality. Equilibrium partitioning models (Mackay, 1982) indicate that approximately 56 percent of the methylene chloride will sorb onto soil particles while 33 percent will be available for transport with percolating water in the unsaturated zone. The portion of the methylene chloride available for transport has probably already leached over time but due to low concentrations and processes such as dilution and dispersion, no impact on groundwater quality occurred and levels were below detection limits. Therefore, it is unlikely that the residual methylene chloride present in the subsurface soils will further leach and significantly degrade groundwater quality.

Surface Water

As noted above, there are no outlets from the drainage ditch, therefore no subsequent movement beyond the ditch of the surface water is expected. As surface water levels fluctuate in dry and wet seasons, metals present in the surface water will sorb to the soil/sediment.

Groundwater

TPH as Gasoline, PAHs, and chlorinated hydrocarbons were present in groundwater samples collected from the Former UST Area and hydraulically downgradient of it, OWS and Sandbox areas. Individual gasoline constituents, which have less affinity to sorb in the soil systems, will dissolve in the presence of percolating water in accordance with their individual aqueous solubility. The TPH as Gasoline and PAHs, due to their low density and low aqueous solubility, would tend to migrate to the top of the water table and migrate as a dissolved phase as long as groundwater concentrations do not exceed each compound's aqueous solubility. These compounds can be moderately persistent in the soil system; however, volatilization and biodegradation are significant fate processes. Constituents of Gasoline such as ethylbenzene, toluene, and xylenes were also detected in groundwater samples from well MW-117 downgradient of the Former UST Area and several downgradient DPT points. The concentrations of ethylbenzene, toluene, and xylenes detected in groundwater samples are three orders of magnitude lower than the aqueous solubility of these compounds. Since these compounds are present in groundwater at concentrations significantly lower than their individual solubility, they are in a dissolved phase rather than as a separate phase. The presence of these compounds in groundwater is the result of the original release from the Former UST Area as well as leaching from the soil pile adjacent to the former UST excavation. Since the surface and subsurface soils contaminated with TPHs have been removed during the excavation, leaching of these compounds to groundwater has been significantly reduced by removal of the source. Since only surface soils contain low concentrations of TPH compounds, the potential for leaching of these compounds to groundwater has been significantly reduced.

The chlorinated hydrocarbons detected in groundwater are also associated with the release from the Former UST Area and the soil pile. PCE was present in groundwater at roughly 0.25 percent of its aqueous solubility. PCE was detected in only 3 of 49 soil samples. Although PCE was detected in groundwater, soil results indicate that the majority of the PCE has already volatilized and/or leached out due to a high percolation rate because medium to fine grained sands (moderate pore spaces for water migration) are present at the LARC 60 site. Two DPT groundwater points were sampled adjacent to SB-20 where the highest PCE concentration (71 ug/kg) in soils was detected with no PCE detected in groundwater. Additional impacts to groundwater quality through further leaching of PCE would not be anticipated.

Degradation products (TCE and cis 1,2-DCE) were also present which indicates that degradation of PCE is occurring. Although vinyl chloride was not detected during the RI, there is a potential for continued degradation of PCE, TCE and cis 1,2-DCE to vinyl chloride. In comparison to concentrations established for these degradation products in groundwater during the PA/SI, their concentrations had increased by the time of the RI. The increased concentrations of degradation products indicate that degradation of PCE is occurring as expected.

Human Health Risk Assessment

In the human health risk assessment (HHRA), no adverse exposures to chemicals of potential concern are anticipated for Fort Story personnel or trespassers in the current situation. This is the case for cancer and non-cancer risks in all media types.

For future conditions, Fort Story is expected to remain a government property and the site will not be used for residential housing. However, due to periodic base closure reviews by the federal government, there is the potential for Fort Story to be closed with subsequent development of the land as commercial or residential properties. Therefore, the HHRA addressed potentially exposed residential populations to the surface and subsurface soils and groundwater at the site. The potential exposure pathways established for future land use at the site included residential exposure (adults and children) to contaminated groundwater through ingestion of drinking water, dermal contact with and inhalation of volatilized chemicals while bathing or showering. Significant risks for ingestion of soil or dermal contact with soil were not established, once arsenic (high levels of arsenic are detected in background at the site) is removed as a contaminant of concern.

A summary of the non-carcinogenic and carcinogenic risk for these exposure pathways is provided in the following table:

Human Health Risk Assessment Summary

Exposed Population	Exposure Pathway	Non-Cancer Effects		Cancer Effects	
		PHI	TEHI	TPR	TER
Residential Populations (Adults)	Ingestion of Soil	0.00393	14.8	6.06E-07	2.70E-04
	Dermal Contact with Soil	0.0022		3.41E-07	

Human Health Risk Assessment Summary						
Exposed Population	Exposure Pathway	Non-Cancer Effects		Cancer Effects		
		PHI	TEHI	TPR	TER	
	Ingestion of Groundwater	8.66		2.84E-04		
	Dermal Contact with Groundwater	0.292		**2.46E-06**		
	Inhalation of Groundwater	5.82		**18.1E-05**		
Residential Populations (Children)	Ingestion of Soil	0.0367	37.1	**1.41E-06**	1.81E-04	
	Dermal Contact with Soil	0.00593		2.39E-07		
	Ingestion of Groundwater	20.1		1.72E-04		
	Dermal Contact with Groundwater	0.513		**1.52E-06**		
	Inhalation of Groundwater	16.4		**6.37E-06**		

For Non-Carcinogens:
PHI - Pathway Hazard Index indicates non-carcinogenic risk for specific exposure pathways
TEHI - Total Exposure Hazard Index indicates non-carcinogenic risk for exposed population
Criterion of 1.0 is used to determine if adverse health effects are possible or unlikely.

For Carcinogens:
TPR - Total Pathway Risk indicates carcinogenic risk for specific exposure pathways
TER - Total Exposure Risk indicates carcinogenic risk for exposed population
USEPA Remediation goal of 10^{-4} to 10^{-6} used to assess carcinogenic risk.

Bolded and underlined text indicates carcinogenic risk is within USEPA remediation goal of 10^{-4} to 10^{-6}.
Shaded areas indicate hazard is above the non-cancer criterion of 1.0 or above the carcinogenic risk level of 10^{-4}.

As presented in the table above, the HHRA showed that there are significant risks for both adult and child residents at the site. These populations may be exposed to the risks by ingesting or inhaling groundwater.

Ecological Risk Assessment

It was recommended in the ecological risk assessment (ERA) that no further investigation of ecological risk be conducted for the site. Ecologically, much of the site provides little value to wildlife for foraging or nesting habitat. Therefore, the risks to wildlife associated with the ongoing activities at the LARC 60 Maintenance Area are considered low.

Recommendations from RI

The completion of a feasibility study (FS) was recommended for the LARC 60 Maintenance Area based on the results of the risk assessment that indicated potential risks as noted below:

- The non-carcinogenic total exposure hazard index for groundwater is greater than the criterion of 1.0 for adults and children with the majority (approximately 99.9 percent) of this risk associated with exposure to contaminants in groundwater.

- The estimated cancer risk for exposure to chemicals in soils and groundwater is about 3 in 10 thousand for adults and 2 in 10 thousand for children. The greatest component for adult and children exposures is ingestion of arsenic in groundwater (98 percent of total risk). In addition, the risk associated with exposure to contaminated groundwater from arsenic and vinyl chloride is greater than the USEPA remediation goal.

REMEDIAL ACTION OBJECTIVES

The remedial action objectives (RAOs) described in this section were developed for the site based on the findings of the human health and ecological risk assessments presented in the RI Report (Malcolm Pirnie, 2002) and will be used as the basis to select the most cost effective remedial action for the site. The HHRA determined that there were potential risks to human health in resident adults and children. No ecological populations were found to be exposed to significant risks. The risk to human health was primarily from exposure to chlorinated volatile organic compounds (VOCs) and metals in site groundwater.

The RAOs; applicable, or relevant and appropriate requirements (ARARs); as well as preliminary remediation goals are developed below for remediation of the groundwater at the site.

2.1 REMEDIAL ACTION OBJECTIVES

RAOs are site-specific, initial clean-up objectives that are established on the basis of the nature and extent of contamination, the resources that are currently and potentially threatened, and the potential for human and environmental exposure.

The RAOs for the LARC 60 Maintenance Area focus on the remediation of organic compounds in the site groundwater. Based on the RI, the specific chemicals/compounds of concern (COCs) in groundwater are cis-1,2-DCE, toluene, vinyl chloride, and naphthalene. These compounds have been designated as COCs because the detected concentrations are above a regulatory limit and/or the risk associated with the compound was greater than the acceptable levels. It should be noted that methyl isobutyl ketone (MIBK) was identified as a COC in the RI but the EPA RBC for tap water has increased to the point that no MIBK detects at the site exceed it, and therefore, MIBK is no longer considered a COC.

There have been two subsequent groundwater monitoring events (2003 and 2004) conducted after completion of the RI. The results of these two monitoring events are presented in Table 6 in Appendix D which presents the Groundwater Pilot Study Report that was conducted at the site in 2004 to evaluate the potential for use of in situ chemical oxidation as a site remedy. VOCs detected above regulatory criteria during these sampling events include benzene, bromodichloromethane, chloroform, cis 1,2-DCE, tetrachloroethene (PCE), toluene, trichloroethene (TCE), and vinyl chloride. Toluene, cis 1,2-DCE, and vinyl chloride have already been identified as COCs for the site.

Risks associated with these compounds are to future, residential receptors (adult and children) ingesting or inhaling groundwater. The RI concluded that risks to environmental receptors at the site are low, therefore no further action need be taken to address environmental receptors.

The RAOs for the remediation of site groundwater are as follows:

- Prevent present human consumption and inhalation of contaminated groundwater that would result in a total site cancer risk in excess of 10^{-6} (1 in one million) and a non-cancer risk where the hazard index is greater than 1.

- Assuming residential housing is developed in the area, reduce potential health impacts to potential future adult and child residential populations from ingestion of and inhalation of groundwater.

- Remediate groundwater to meet chemical specific ARARs as appropriate or to an acceptable level of risk if no chemical specific ARARs exist.

One organic compound, 2-methylnaphthalene, was considered a compound of potential concern (COPCs) in the RI, however the compound was not found to pose a significant risk and there is no regulatory limit for the compound. 2-Methylnaphthalene is not considered further in this FS.

There are four inorganics that were discussed in the RI as COPCs. These inorganics antimony, arsenic, manganese, and iron are not considered further in this FS for the reasons noted below:

- Antimony: Individual non-carcinogen Hazard Quotients and cancer risks are within acceptable levels and these values are not significant contributors to the overall pathway Hazard Indices or Total pathway cancer risks. The maximum level detected is below the maximum contaminant level (MCL) for Antimony.

- Arsenic: Though Arsenic is a significant contributor to both noncarcinogen and carcinogen risks, the calculations are based on only one detection from the six wells sampled. Arsenic was non-detect in the other five wells. It is therefore reasonable to conclude that the one arsenic detection is an anomaly and does not constitute a contaminant in the overall groundwater regime.

- Manganese: Individual non-carcinogen Hazard Quotients and cancer risks are within acceptable levels and these values are not significant contributors to the overall pathway Hazard Indices or Total pathway cancer risks. Though the manganese concentrations detected in groundwater are above the established MCL, it is a secondary MCL. The intent of secondary MCLs is to set up non-enforceable guidelines for evaluating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. Similarly, the Virginia groundwater quality criteria (per 9VAC25-260-230) were intended to provide guidance, but were not adopted as enforceable standards, for naturally occurring metals such as Manganese and Iron. Since there is little possibility of the site being rezoned for residential use and those residents having their water supplied from the shallow aquifer in close proximity to the salt water/fresh water divide, it is not appropriate to remediate for this contaminant.

- Iron: Though the iron concentrations detected in groundwater are above the established MCL, it is only a secondary MCL. The intent of secondary MCLs is to set up non-enforceable guidelines for evaluating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. Similarly, the Virginia groundwater quality criteria (per 9VAC25-260-230) were indented to provide guidance, but were not adopted as enforceable standards. Since there is little possibility of the site being rezoned for residential use and those residents having their water supplied from the shallow aquifer in close proximity to the salt water/fresh water divide, it is not appropriate to remediate for this contaminant.

2.2 APPLICABLE, OR RELEVANT AND APPROPRIATE REQUIREMENTS

The regulatory requirements that must be reached during the remedial action are identified in this section for use in evaluating the remedial alternatives for their ability to comply with the regulations.

The National Contingency Plan (NCP) and Section 121 of the Comprehensive Environmental Response, Compensation and Liabilities Act (CERCLA) require that CERCLA remedial actions comply with Federal and State Applicable, or Relevant and Appropriate Requirements (ARARs), unless specific waivers are granted. State ARARs must be attained under Section 121(d) of CERCLA, if they are more stringent than federal ARARs, legally enforceable and consistently enforced statewide. ARARs may be classified as either applicable or relevant and appropriate. In addition to ARARs, other guidance and regulations may be classified as guidance "to be considered" (TBC).

ARARs and TBCs are used in the development of remedial actions, in the establishment of required cleanup levels, to scope and formulate remedial action alternatives, and to govern implementation and operation of the selected remedial alternatives. ARARs are developed on a site-specific basis so that the unique characteristics can be evaluated and compared to those requirements that apply under the given circumstances.

This section discusses the definition of ARARs and TBC criteria, the development of ARARs, and the preliminary identification of ARARs for LARC 60 Maintenance Area.

2.2.1 Definition of ARARs

Definitions of ARARs and TBC criteria are as follows:

- **Applicable Requirements.** Applicable requirements refer to those Federal or State requirements that would be legally enforceable. An example of an applicable requirement would be the Safe Drinking Water Act's MCLs for a site that contaminates a public drinking water supply.

- **Relevant and Appropriate Requirements.** Relevant and appropriate requirements are Federal or State standards, criteria or guidelines that are not legally enforceable at a site, but where application is appropriate because they address problems similar to those on-site. Relevant and appropriate requirements have the same weight and consideration as applicable requirements. An example of Relevant and Appropriate Requirements might be state groundwater protection levels established for a UST regulatory program.

- **To Be Considered (TBC).** Other Federal and State recommended standards or criteria applicable to a specific site, which are not generally enforceable but are advisory, are categorized as TBC. For example, where no specific ARAR exists for a chemical or situation, or where such an ARAR is not sufficient to be protective of human health or the environment, Federal and/or State guidance or advisories may be considered in determining the necessary level of cleanup for protection of public health and the environment. An example of a TBC would be use of EPA risk screening criteria or EPA Health Advisories for specific chemicals in determining action or cleanup levels.

2.2.2 Development of ARARs and TBCs

The development of ARARs and TBCs is conducted on a site-specific basis. ARARs and TBCs are further categorized as chemical-specific, location-specific or action-specific. CERCLA actions may have to comply with them as follows:

- **Chemical-Specific**. Chemical-specific requirements define acceptable exposure levels for specific hazardous substances and therefore may be used as a basis for establishing preliminary remediation goals and cleanup levels for chemicals of concern in the designated media. Chemical-specific ARARs and TBCs are also used to determine treatment and disposal requirements for remedial actions. In the event a chemical has more than one requirement, the more stringent of the two requirements will be used.

- **Location-Specific**. Location-specific requirements set restrictions on the types of remedial actions that can be performed based on site-specific characteristics or location. Alternative remedial actions may be restricted or precluded based on Federal and State laws for hazardous waste facilities and proximity to wetlands, floodplains, or to man-made features such as existing landfills, disposal areas, and historic structures.

- **Action-Specific.** Action-specific requirements set controls or restrictions on the design, implementation, and performance of remedial actions. They are triggered by the particular types of treatment or remedial actions that are selected to accomplish the cleanup. Action-specific ARARs and TBCs which specify remedial action performance levels as well as specific contaminant levels for discharge of media or residual chemical levels for media left in place are used as a basis for assessing the feasibility and effectiveness of the remedial action alternatives.

2.2.3 Identification of ARARs and TBCs

Preliminary lists of chemical-specific and action-specific ARARs and TBC Criteria have been complied in **Tables 2-1 and 2-2**, respectively.

No location-specific ARARs were identified for this site. The preliminary action-specific ARARs have been identified based on a variety of potential remedial action alternatives and the final ARARs must be definitively identified after selection of a remedial alternative.

Several types of regulations are not considered applicable ARARs for the LARC 60 Maintenance Area remedial actions including:

- Virginia and Federal Wetland Regulations – No wetlands are located on or adjacent to the site. Therefore, these regulations are not applicable.

- Virginia and Federal Endangered Species Act - No state or federally listed threatened or endangered species or critical habitat areas have been identified at the site. Therefore, these regulations are not applicable.

- National Historical Preservation Act, Archaeological Historic Preservation Act, and Virginia Historic Resources Law and Antiquities Act. No historic, archaeological, or cultural resources have been identified in or adjacent to the site, so these regulations are not applicable.

2.3 PRELIMINARY REMEDIATION GOALS

Quantitative remediation goals will be established in this section that address the RAOs for the site.

2.3.1 Chemical-Specific ARAR and TBC Applicability

A discussion of each of the ARARs and TBC in relation to their applicability as a clean-up goal of site groundwater is discussed as follows.

Safe Drinking Water Act MCLs

Primary MCLs are enforceable contaminant concentration limits for drinking water. Since the water may be used as a drinking water source in the future it is appropriate to consider decreasing contaminant concentrations to within the primary MCL levels.

Virginia Groundwater Quality Standards

Virginia groundwater quality standards are the state's equivalent to the federal MCLs. The groundwater quality standards will be used in place of appropriate MCLs when they are more stringent than the MCLs.

EPA Region III RBCs

EPA RBCs for tap water are generic in their approach to risk evaluation. However, as a TBC, they can be used to loosely establish groundwater clean-up criteria for the site since the concentrations are conservative estimates of the amount of a contaminant that may cause a health risk from drinking water.

Virginia Petroleum Program

Action levels are not specified in the program. The action levels for contaminants are to be made on a site-specific basis. The action levels for this site will be the PRGs established below.

Virginia Groundwater Quality Criteria

The groundwater quality criteria are for naturally occurring substances in groundwater, such as iron, that may cause a taste, odor, or aesthetic issue. The criteria are suggested concentrations levels for the natural substances that are below the level at which the taste, odor, or aesthetic issues will be noticed. The criteria have not been promulgated into enforceable standards.

2.3.2 Establishment of Remediation Goals

Preliminary remediation goals (PRGs) are established on the basis of regulatory concentration limits, the results of the HHRA, and the evaluation of the expected exposures following remedial action. Remediation goals will be evaluated on the following factors:

- Provides protection from carcinogens within the risk range of 10^{-4} to 10^{-6}.
- Provide protection from non-carcinogens such that the hazard index is not greater than 1.
- Adequately addresses each significant pathway of exposure (groundwater ingestion and

inhalation for this site).

In order to meet the general goals cited above, PRGs have been calculated and/or established for the site. The PRGs focus upon the organic constituents (i.e., SVOCs and chlorinated VOCs) as noted previously in this section. PRGs are based on two main criteria. First, for COCs with a primary MCL, the MCL will be used as the PRG. For contaminants without an MCL a risk-based PRG will be calculated. For the additional VOCs (those not listed as COCs from the RI report) detected above the EPA RBCs in the 2003 and 2004 monitoring events, a comparison to the MCLs was conducted because the PRGs for these compounds will be the MCLs. Benzene, bromodichloromethane, and chloroform concentrations were well below the MCLs, and therefore, they are not identified as COCs and no PRG will be established for them. Although PCE and TCE only exceeded the MCL in 1 of 14 wells sampled in 2004, they will be identified as COCs and PRGs will be established for them. The maximum detected concentration of toluene (310 ug/L) is less than the 1,000 ug/L MCL; therefore no further action need be taken to address the toluene in groundwater at the site. MCLs are used as the PRG for cis 1,2-DCE, PCE, TCE, and vinyl chloride.

Risk-based PRGs were calculated for naphthalene. The calculations for risk-based PRGs were based on a child exposure because the RI shows children have the highest health risks for naphthalene exposures. The use of the child exposure is the most conservative and will be protective for future residential adults. The parameters used to calculate the risk-based numbers are provided in **Appendix B**. The PRGs were calculated to equate to the contaminant concentration at which there would be a hazard quotient (HQ) of 0.1 for a child. An HQ of 0.1 was used due to the cumulative noncarcinogenic effects of the contaminants.

The calculated PRG for naphthalene (0.22 ppb for a HQ of 0.1) is below the reporting limit of 1 ppb and is close to the method detection limit of 0.21 ppb. To avoid the likelihood of false positive detections of naphthalene, which was only detected in one monitoring well (MW-117), the risk-based PRG for naphthalene for a combined pathway HQ of 1.0, 2.2 ppb is proposed. Due to the infrequent detection of naphthalene and the conservative scenario used to calculate the PRG, the proposed 2.2 ppb PRG will be protective of human health.

For the final identified COCs (1,2-DCE, naphthalene, PCE, TCE, and vinyl chloride), the PRGs are summarized in **Table 2-3**.

The PRGs will be used to evaluate the effectiveness of the chosen remedial alternative. Monitoring of the site groundwater will be conducted for evaluating any residual contamination left on-site and will aid in determining any additional risk management decisions as part of the 5-year review process. It should be noted that any other VOCs detected above the MCL in future monitoring events will be included as a COC with the MCL established as the PRG.

2.4 AREA OF AFFECTED MEDIA

COCs were detected in varying concentrations throughout the site, therefore the contamination will be addressed on a site-wide basis.

Section 3 DEVELOPMENT AND SCREENING OF TECHNOLOGIES

The purpose of this section is to develop the general response actions, and to identify and screen remedial technologies and process options applicable to the site. General response actions describe those actions that will satisfy the remedial action objectives (RAOs). General response actions may include treatment, containment, excavation, disposal, institutional controls, or a combination of these. Technology types are defined as general categories such as chemical treatment, thermal treatment, and capping while process options are specific processes within the general technology types. For example, the chemical treatment technology may include process options such as glycolate dechlorination or solvent extraction. The list of technology types and process options developed in this section will be specific to the treatment of contaminated groundwater.

One step in the screening procedure for technologies and process options is addressed in each of the sections of this report.

- **Section 3.1** - Identification and initial screening using technical implementability of general response actions and potential remedial technologies that address site problems and meet remedial goals and objectives. Only the technology types and process options that are applicable to the existing site conditions will be retained for further evaluation. This initial screening is conducted in order to limit the number of technology types and process options that undergo detailed analysis.

- **Section 3.2** – Further screening of technologies for suitability at the site based on their effectiveness, implementability, and cost as well as the technical reliability of the technology.

- **Section 3.3** lists the technology types and process options retained for detailed analysis.

3.1 GENERAL RESPONSE ACTIONS

General response actions (GRAs) and identified technologies to meet the remedial objectives at the LARC 60 Maintenance Area fall into the following categories which are also listed in **Table 3-1**:

- No Action
- Monitoring
- Institutional Controls
  - Access restrictions
  - Land use restrictions
- Containment
  - Barrier wall
  - Interceptor trench

- Groundwater Extraction
  - Groundwater pumping
  - Dual phase extraction

- Treatment Technologies, in-situ and ex-situ (ex-situ technologies would be coupled with a groundwater extraction technology)
  - In-Situ (chemical, physical, biological, and thermal)
  - Ex-Situ (chemical, physical, biological, and thermal)

- Groundwater Disposal Options
  - On-site, subsurface Injection
  - Discharge to storm sewer
  - Discharge to Publicly Owned Treatment Works (POTW)

The technical implementability of each technology in a GRA was evaluated to determine if further evaluation were necessary. Technical implementability includes such factors as types and levels of contaminants, site characteristics (e.g., water content of soils, organic matter content, grain size of sediment), and the limiting factors associated with the technology type. In particular, the presence of inorganic contaminants is one factor that commonly limits the application of many treatment processes. In the initial screening stage, technologies that could not effectively treat or remove organic contaminants from groundwater are not considered to be implementable, and are therefore removed from further consideration.

Based on these factors, several technologies were eliminated from further consideration. The rationale for eliminating these technologies is described below.

- In situ biological treatment through phytoremediation was eliminated from consideration because the physical characteristics of the site are not suitable for the use of this technology. The site is largely paved over in the areas where contaminant concentrations are the highest. Removal of the paved areas for the use of phytoremediation without severely hampering the mission of the LARC 60 Maintenance Area is infeasible.

- Extraction via dual phase extraction was eliminated from further consideration. Dual phase extraction is generally used for removal of groundwater and vapors in unsaturated soil. Since contamination in the unsaturated zone is not an issue at the site, the use of dual phase extraction is unwarranted. Pumping of groundwater alone is sufficient based on site characteristics.

- The In situ physical treatment of bioslurping was eliminated from further consideration. Bioslurping is combination approach using both venting and free product recovery techniques to remediate a site. It is typically used for unsaturated zone contamination and product recovery. Both of these issues are not present at the site.

- The In situ physical treatment of soil vapor extraction (SVE) was eliminated from further consideration. SVE is not effective in the saturated/groundwater zone. It may be effective in conjunction with another technology, such as air sparging; however as a stand-alone technology it would be ineffective at the site.

- Thermally enhanced SVE was also eliminated from further consideration. As noted above, SVE is not effective in the saturated zone. Enhancing SVE with heat does not rectify this failing of SVE.

- The In situ physical treatment of fracturing was eliminated from further consideration because the soils at the site do not have a low permeability. Fracturing of soil is typically only needed for silt and clay type soils that are not conducive to the movement of chemicals injected for remedial purposes. At this site the soils are considered permeable and will not require fracturing to allow the passage of chemicals used in in situ remediation.

- The ex situ chemical treatment of ion exchange was eliminated from further consideration. The ion exchange technology is ineffectual against most volatile organic compounds. It therefore is inappropriate for the site.

- The ex situ chemical treatment of precipitation was eliminated from further consideration. Precipitation is ineffectual against most volatile organic compounds. It therefore is inappropriate for the site.

- Sprinkler irrigation, an ex situ physical treatment, was eliminated from further consideration because the physical characteristics of the site are not suitable for the use of this technology. The site and adjacent areas are largely urbanized. There is insufficient room on site or near the site to place an irrigation system.

- Constructed wetlands, an ex situ biological treatment, was eliminated from further consideration because the physical characteristics of the site are not suitable for the use of this technology. The site and adjacent areas are largely urbanized. There is insufficient room on site or near the site to place a constructed wetland.

3.2 EVALUATION OF PROCESS OPTIONS

In this section, the technology process options considered to be implementable, listed in **Table 3-1**, are evaluated in greater detail before selecting processes to represent each technology type.

3.2.1 Evaluation Criteria

Remedial alternatives will be screened to eliminate those that are not effective, implementable or reasonable in cost. A description of the criteria used to determine the effectiveness, implementability, and economical cost of a remedial alternative to be used in this initial screening is provided below. These criteria are utilized again (in conjunction with others) during the detailed analysis evaluation in Section 5.0 of this report. In the screening step, technologies are evaluated qualitatively only based on their effectiveness, implementability, and cost.

Effectiveness

An important aspect of the screening process is evaluation of the effectiveness of each alternative in protecting human health and the environment. Each alternative is evaluated based on its effectiveness in providing protection and in reducing the contaminants' toxicity, mobility, or volume. Both short- and long-term components of effectiveness are evaluated. Short-term effects are those effects that occur during the construction and implementation period; and long-term effects refer to the period after the remedial action is complete. Reduction of toxicity, mobility or volume refers to changes in one or more characteristics of the hazardous substances or contaminated media by the use of treatment that decreases the inherent threats or risks associated with these substances.

Implementability

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. It is used during screening to evaluate the combinations of process options with respect to conditions at a specific site. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete. It also includes operation, maintenance, replacement, and monitoring of technical components of an alternative, if required, after the remedial action is complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies, the availability of treatment, storage and disposal services and capacity, and the requirements for, and availability of, specific equipment and technical specialists.

Cost

Typically, alternatives are defined well enough before screening to estimate some costs for comparison to other alternatives. However, because uncertainties associated with the definition of alternatives often remain, it is not practical to define the costs of alternatives with the accuracy desired for the detailed analysis. At this stage in the evaluation, the cost analysis is made based on engineering judgment. The costs of each process option are compared with costs of other process options in the same technology type.

3.2.2 Screening of Process Options

The process options and the results of the screening process are described in the following sections. **Table 3-2** provides a summary of the screening with a listing whether to retain or reject the process option.

3.2.2.1 No Action

The no-action technology, by definition, involves no remedial action at the site, and therefore has no technological barriers. The potential risks to human health and the environment identified in the risk assessment would not be mitigated by this response. The COCs would remain in the groundwater, though they would gradually degrade. This option would not be effective in eliminating the groundwater risks but could be implemented at a very low cost, and therefore, is retained for further consideration as required by the NCP.

3.2.2.2 Monitoring of Groundwater

Monitoring provides an opportunity to evaluate the degradation of the COCs. Monitoring in itself does not reduce the concentrations of COCs in the groundwater. This option has limited long-term and short-term effectiveness, and results in no reduction of mobility, toxicity (other than that contributed by natural attenuation) or volume. Monitoring is, though, most effective in evaluating the effectiveness of remedial actions or degradation by natural attenuation. Under all circumstances, except No Action, Fort Story plans to undertake a monitoring effort at the site to evaluate remedial actions and/or characterize any further impacts to the groundwater at the site.

3.2.2.3 Institutional Controls

Institutional controls may include options such as physical controls or access restrictions (e.g., posting signs or fences) or administrative controls (e.g., land use restrictions). An evaluation of each of these is provided as follows.

Access Restrictions

The installation of fencing around the site and/or posting of "Restricted Access" or "No Access" signs would not reduce the potential for human exposures to contaminated groundwater. Groundwater can migrate off-site or be pumped from the site. Access restrictions are implementable and low cost, but would not be effective for treatment of the contaminants nor in reducing or eliminating human risks and, therefore, will not be considered further.

Land Use Restrictions

Land use restrictions for future use of Fort Story or the site would become an issue if base closure were to occur and the site and surrounding areas were re-developed. Restrictions on land use may reduce the risk to human health, however the contaminants may migrate or be pumped from the site. This option has a relatively low cost, however would not be effective for treatment of the contaminants. The only way to reduce the risks to human health is to treat the contaminants. Once the contamination is treated, then there is no risk remaining to human health. This option will not be retained for further consideration.

3.2.2.4 Containment

Containment technologies include vertical barriers, constructed from low permeable materials or high permeable material with pumping.

Low Permeable Walls

A low permeable wall, such as a slurry wall, would impede additional migration of groundwater from the site. However, vertical barriers would not reduce the human risks of exposure to contaminated groundwater already present. Vertical barriers, although implementable, would not be effective for treatment of the contaminated groundwater nor in reducing the risk of exposure to human receptors. The wall may increase the lateral size of the plume as contaminated groundwater at the wall works its way around the wall. Therefore, installation of a low permeable wall is not retained for further consideration.

High Permeable Walls

Interceptor trenches are vertical walls constructed in-ground with gravel or other high permeable material. The material creates a preferential pathway for groundwater, which is pumped to create a sump. This sump is a hydraulic barrier to contaminated groundwater, thus contamination is unlikely to migrate from the site. This sump could also be created by using a series of wells, which are less expensive to construct. In either case, the collected groundwater must be treated via an ex situ treatment process. Note that since the interceptor trench would be placed on the leading edge of the plume, nonimpacted groundwater would also be pumped into the system. The interceptor trench in this way increases the amount of water that needs to be treated and dilutes the concentration of contaminants. Some technologies are less effective as the contaminant concentration gets lower, thus the interceptor trench may impede remediation in this respect. For the above reasons, high permeable walls are not considered further.

3.2.2.5 Extraction Options

Pumping

Pumping groundwater from the subsurface could be effective and implementable at the site. Application of this technology can be accomplished with a series of wells and a pump system and would be followed by treatment of the contaminated media. As with the installation of any well field proper utility clearance will be required. Due to the urbanized nature of the area, the drill rig will need to be equipped to bore through concrete and asphalt. These two considerations for implementability are not considered a problem.

Pumping of the contaminated groundwater will reduce the amount of contaminants in the subsurface and possibly reduce the overall size of the plume. This will mean reduced risks to future residents. The drawback is that the extracted groundwater must be treated and ultimately disposed of. Overall, pumping can be effective at reducing risks, implementable by common construction methods, and moderate in cost; therefore, it will be included for further evaluation.

3.2.2.6 In-situ Treatment Options

Chemical, physical, and thermal process options have been identified as potential in-situ treatment technologies for the site. A summary of these options is provided below.

Chemical Treatment

Chemical Oxidation

In situ chemical oxidation (ISCO) is a process involving a chemical reaction (oxidation) that converts contaminants into innocuous products. It is a proven technology with a relatively fast reaction rate (compared to other remediation technologies) and capable of destroying chlorinated solvents. The reduction of contaminants can be completed in days or weeks instead of years; however the reaction rate and efficacy depend on the chemical (electron acceptor) used; the in situ delivery system; the target organic contaminants, and the site conditions (e.g., pH, temperature, and organic matter content). The site's COCs are well suited for remediation treatment by ISCO. Other advantages of ISCO include: no discharges requiring handling, readily available materials for use in the process, and numerous vendors offering the service. Some disadvantages with this technology include: additional safety requirements in handling the chemicals due to their reactivity; possible need for re-application if contaminants rebound; and it may require a large well field. The cost of an ISCO treatment will be dependent on the type of chemical selected for use and the number of wells required; the cost of well installation will depend on the type and depth of the wells used. ISCO is a good candidate for the site due to its proven technology and capability of destroying the COCs. ISCO is retained for further consideration.

Reactive Treatment Walls

Reactive treatment walls, or permeable reactive barriers (PRBs), are constructed by excavating a trench perpendicular to the groundwater flow path, and filling it with a reactive material, such as granular iron. Contaminants, such as chlorinated solvents, react with the material as groundwater flows through the barrier, thus reducing the contaminant concentrations and producing innocuous products. To be effective the PRB must be long enough to catch the plume and deep enough to be founded on bedrock or other impermeable barrier. This can increase the cost of this option significantly and/or make the technology infeasible if the plume is very wide or the depth to an impermeable barrier is great. At this site, construction may need to be deep to found the barrier on a low permeable material.

As for treatment, the technology is passive in that contamination must flow to the wall in order for treatment to occur. This process can be slow depending on the groundwater flow rate. The technology is also susceptible to contaminant break through (i.e., the reactive material becomes exhausted in a portion of the wall, thus allowing contaminants through) and metal and/or biological fouling. If fouling occurs, it will cause a decrease in permeability, which may cause groundwater to flow around, over, or under the wall in a more permeable material. Monitoring of fouling and contamination breakthrough would be required. Both problems may require reconstruction of the wall or additional remedial efforts.

Due to the possible problems with finding a suitable foundation for the barrier and monitoring and maintenance associated with fouling and breakthrough, this technology is not considered further.

Physical Treatment

Air Sparging

Air sparging is a process by which air is injected into the contaminated subsurface to volatilize VOCs and SVOCs in the groundwater. Air sparging can be effective with the volatile COCs on site and the added oxygen may also stimulate biodegradation. Disadvantages of air sparging include: airflow interference by soil heterogeneities, the potential for uncontrolled movement of vapors due to non-uniform airflow, process is not as effective for semi-volatiles (e.g., naphthalene), and the need for a large well field.

Once the COCs are volatilized, a soil vapor extraction system (SVE) will be required to collect the contaminants. SVE is a proven technology and is often used in conjunction with air sparging. The main disadvantages of SVE include: additional, near-surface wells will be required for vapor extraction in addition to the wells used for air sparging; soil heterogeneities will affect vapor flow paths; and high organic content or extremely dry soil will adsorb contaminants, thus reducing removal rates. If the contaminants are sorbed on the soil, then additional remediation may be required. In addition, once the vapors are extracted from the groundwater, they will require treatment.

As noted above, vapor movement may not be completely controlled by the SVE system. This may cause problems in an urbanized area, because the vapors could find preferential pathways along or within piping. This could lead to build up of contaminants in and around buildings, which may cause hazards to the workers at the site. Due to this possible complication and the other disadvantages noted above, air sparging/SVE is not considered further.

In-well Air Stripping

This technology is similar to air sparging. For this technology, air is injected into a well that has been screened at two depths. The lower screen is located in the groundwater; the upper screen is in the unsaturated zone. Air is injected at the lower screen to volatile contaminants into the well. These contaminants are then forced out at the upper screen and into the soil regime. A SVE system is used to collect the vapors from the soil.

This technology has several disadvantages that do not make it amenable to the site. First, the technology is not well suited for shallow groundwater systems. This is because the contaminants would be discharged close to the ground surface, thus the contaminants may migrate to the atmosphere before an SVE system could effectively capture them. This could lead to health risks for site workers or odor problems near the wells. Also, the radius of influence is generally small, so much of the plume will not be remediated without an extensive well field.

This technology has not received as much attention in the United States as it has in Europe. Consequently, there is a smaller pool of vendors and contractors familiar with this technology. This may increase the cost, because there is not a competitive environment in this technology field.

Based on the above discussion, this technology is not considered further.

Biological Treatment

Bioremediation

This process accelerates natural microbial degradation of organic contaminants in groundwater by providing nutrients, substrates (electron acceptors), and/or microorganisms through a well system to aid in the consumption of contaminants. Bioremediation can be effective in both aerobic and anaerobic systems for the reduction of the site's COCs. There are numerous vendors providing various substrates, such as oxygen, hydrogen peroxide, or nitrate, for use in either or both environments. Also, the technology produces no effluents or other wastes that require handling.

Disadvantage include: difficulties in treatment delivery due to heterogeneous media; slow solution process; may require large well field; and efficacy is highly dependent on groundwater geochemistry. However, the COCs at the LARC 60 Maintenance Areas generally indicate that biodegradation is on-going at the site. Costs of the process are dependent on the type of nutrients or substrates required and the number of wells needed. Bioremediation is retained for further consideration.

3.2.2.7 Ex-situ Treatment Options

Chemical, physical, and thermal process options have been identified as potential ex-situ treatment technologies for the site. A summary of these options is provided below.

Chemical Treatment

Advanced Oxidation

This is a process involving a chemical reaction (oxidation) that converts hazardous contaminants into innocuous products. A chemical substrate is added to the contaminated water and then irradiated by UV light, which causes a reaction to eliminate contaminants. The main advantage of this technology is that it can virtually eliminate the COCs.

Disadvantages include: the need for additional safety measures in handling the chemical substrates due to their reactivity; the technology is energy intensive, and the system has high maintenance requirements. Also, the effluent water will need to be handled and disposed of. Since many other technologies can effectively reduce the COC concentrations without the high energy requirements and need for continuous maintenance, this technology is not considered further.

Physical Treatment

Air Stripping

Air stripping is an ex situ treatment process in which volatile contaminants in water are transferred to air. This is completed by increasing the surface area of the contaminated water exposed to air through spraying or cascading the water. Air stripping is a proven technology in the reduction of volatile organic concentrations in water, and there are numerous vendors with pack systems available for use. The cost of the air stripper will be dependent on the amount of groundwater that will be treated.

Disadvantages of air stripping include: fouling of the equipment by inorganic and/or biological constituents, the creation of effluent water that needs to be disposed of, and the need for subsequent treatment of vapors created. Though air stripping creates two waste streams that will require disposal and/or treatment, the technology will be considered further because of its proven ability and ease of implementation.

Carbon Absorption

In this technology, contaminated liquid or vapors are pumped through columns filled with activated carbon where contaminants are sorbed to the carbon. When the granular carbon is saturated by the contaminants, the carbon must be regenerated or replaced with more activated carbon. The main advantage of this technology is its effectiveness in treating numerous contaminants over a large range of concentrations and flow rates. However, the process may not efficiently remove some of the site's COCs, such as vinyl chloride. The carbon columns require monitoring to ensure against contaminant breakthrough and replacement of carbon. These factors make the technology an operation and maintenance intensive technology. Since carbon adsorption may not be effective against all the site's COCs and its maintenance intensive nature, it will not be considered further.

Separation

Separation is a process by which contaminants in wastewater are concentrated in smaller volumes of waste via numerous physical and/or chemical means. One such separation process that may work on the site's COCs is membrane pervaporation. In this process, permeable membranes are used to remove COCs from contaminated water. The COCs are subsequently discharged into another liquid stream but at high concentration levels. The process reduces the volume of waste, but does not destroy the COCs. There are two effluents from the process. The large effluent is the treated water. The smaller effluent will contain a concentrated amount of COCs that need to be treated by an additional on-site treatment train or disposed of off-site. Since separation process does not destroy the contamination, but merely concentrate it, separation is not considered further.

Thermal Treatment

Thermal treatment can be implemented either at high (exceeding 200°F) or low (below 200°F) temperatures.

Flare System

This thermal treatment utilizes a combustion engine in which the high temperatures created by the combustion of a fuel source destroy contaminants. The technology offers essentially complete destruction of the original organic waste. However, the technology is typically for vapor phase contaminants. In order to use the technology at this site a pretreatment would be required to transfer the contaminants to the vapor phase. The technology is commonly used in the destruction of landfill gas compounds and has been shown effective in the destruction of contaminants like the site's COCs. A disadvantage of the technology is that an air permit may be required in order to use the flare.

Due to the effectiveness of flare systems in destroying the site's COCs, this technology is retained for further consideration.

Thermal Oxidation

The technology of thermal oxidation uses a catalyst to accelerate the rate of destruction of contaminants. This technology can be completed at lower temperatures, in the range of 600° to 1,000° F, than conventional combustion with the help of the catalyst. Thermal oxidation is a relatively new technology, but there are a number of vendors manufacturing equipment and/or supplying catalysts.

This process has been shown to reduce the types of contaminants at the site. However, certain types of contaminants, particularly halogenated compounds such as TCE, can poison or deactivate the catalyst. To avoid this special/proprietary catalysts may be required or the system will require a higher amount of maintenance in order to replace the catalysts as required.

Due to the relative newness of the technology, the capital cost can be higher than proven/more conventional technologies. Frequent replacement of catalyst can also drive up the cost in the long run. Based on the possible high costs and problems with the catalysts, this technology is not considered further.

Biological Treatment

Bioreactors

This ex situ treatment process uses microorganisms to degrade contaminants in the water. This type of technology is extensively used in the wastewater treatment industry. Biological treatment is a proven technology and can be purchased in fully functional, modular components making the system easy to assembly and implement at the site. However, the site's COCs will require specialized systems, thus the number of vendors that can complete the work will be reduced. Costs will be dependent on the influent rate and concentrations of the contaminants.

One drawback of this technology is the need for significant operator attention to ensure the loading of the system is keep within required parameters. Without intensive maintenance of the system, the microbes can be highly vulnerable to too high or too low contaminant concentrations. These situations may kill or starve the microbes, thus making the system ineffective. Other disadvantages of the system include: effluent will need to be handled and disposed of, the sludge created will have to be handled and disposed, and there can be odor issues with these types of systems. Due to the numerous disadvantages, including the possible failure of the system, this technology will not be considered further.

3.2.2.7 Disposal Options

Three options have been identified as being potentially applicable for disposal of treated groundwater. These are noted below.

Discharge to Subsurface

One option for the disposal of effluent waters created by ex situ treatment processes, is the injection of these waters back to the groundwater regime. This can be done by creating a separate well field away from the plume and pumping the effluent back to the saturated zone through those wells. The capital cost of this option will be based on the number of wells, pumping equipment, and piping required to complete the well field.

There are two difficulties with this option. First, permitting for groundwater injections can be difficult. Both EPA and DEQ will have to approve of the injection. At present, both agencies are likely to decline these types of permits. Second, the injection may change groundwater flow in an undesirable manner. The groundwater table at the site is relatively flat and any mounding created by the discharge could change the flow pattern in the location of the well field. Also, the groundwater table is shallow, so the mounding effect may create seeps or discharge to low-lying areas. With these difficulties, this option is not considered further.

Discharge to the Storm Sewer System

Effluent waters from ex situ treatment processes could be discharged to a storm sewer at Fort Story. The capital costs would be minimal. All that would be needed is a discharge pipe to connect to the existing storm sewer. However, the costs could rise if the existing pipes are not large enough to handle the added flow in conjunction with its normal loading of precipitation run-off.

The main difficulty with this option is the need for discharge permitting. Since the water would be essentially discharging to the environment (i.e., a wetland or surface water body) a pollution discharge permit will be required. Depending on the existing discharge permits for Fort Story, an existing permit may need to be modified or a new permit prepared. Sampling of the sewer discharge pipe will also be likely in order to show that the effluent is not creating a problem in the receiving water body. Due to the difficulties of permitting and the need for sampling, this option will not be considered further.

Discharge to Publicly Operated Treatment Works (POTW)

The base currently discharges its industrial and sanitary wastewater to the Hampton Roads Sanitation District's (HRSD) Chesapeake-Elizabeth Wastewater Treatment Plant. Although discharge to the wastewater system would be effective and low in cost, modification of Fort Story's discharge permit may be required due to a change in waste stream elements. Due to the potential permitting difficulties, this disposal option may have some minor difficulties associated with implementation. However, by discharging to a treatment plant, the effluent water may not need to be as clean as it would for groundwater injection or discharge to the storm sewer. This may decrease costs of the ex situ treatment system in the long run. Though permitting may be an issue at with this option, it is retained for further consideration.

3.3 RETAINED PROCESS OPTIONS

The technologies and process options which will be retained based on the initial screening for their effectiveness, implementability, and cost are summarized as follows.

- No Action
- Monitoring groundwater
- Extraction Options
  - Pumping

- In Situ Treatment Options
  - Chemical Oxidation
  - Bioremediation
- Ex-Situ Treatment Options
  - Air Stripping
  - Flare System
- Disposal Options
  - Discharge to a POTW

Section 4

Development and Screening of Alternatives

The objective of developing alternatives is to assemble the process options and technologies that were retained during screening into remedial action alternatives. The alternatives should be protective of human health and the environment and provide several remedial options.

Remedial alternatives have been developed in an effort to represent a wide range of remedial actions in terms of both cost-effectiveness in protection of human health and the environment, and of level of difficulty in implementation. These alternatives have been developed to meet the RAOs described in Section 2, which focus on preventing human exposure to VOCs and SVOCs in groundwater at the LARC 60 Maintenance Area.

The process options retained in the screening process are listed in Section 3.3. Due to the limited quantity of appropriate technologies, a limited number of remedial alternatives were developed. Since a limited number of remedial alternatives were developed, the initial screening of remedial alternatives will be eliminated and the detailed analyses will be performed. As previously discussed in Section 3.2.2.2, Monitoring of Groundwater, long term monitoring will be part of each alternative; however monitoring is not discussed in detail under each alternative since it will not be a defining factor of any of the alternatives.

Based on the remaining technologies and options screened in Section 3.0, the following alternatives have been formed:

- **Alternative 1** - ***No Action***
- **Alternative 2** – ***In Situ Chemical Oxidation Of Groundwater Contamination***
- **Alternative 3** – ***In Situ Bioremediation of Groundwater Contamination***
- **Alternative 4** – ***Groundwater Pumping to Ex Situ Air Stripping with a Flare System for Off-Gas Destruction***

A description of each is provided in the following sections.

4.1 Alternative 1 - No Action

Under this alternative, no further effort or resources would be expended at the site. Because contaminated media would be left on the site, a review of the site conditions would be required every 5 years. The review is specified in the NCP. Alternative 1 serves as the baseline against which the effectiveness of other alternatives is judged. This alternative is required under the NCP.

4.2 ALTERNATIVE 2 – IN SITU CHEMICAL OXIDATION OF GROUNDWATER CONTAMINATION

This alternative includes the following steps:

- Pilot Study to determine type and quantity of oxidizer to use, optimize well spacing, and refine delivery methods for oxidizer;
- Installation of a well field;
- Initial remedial action, the distribution of oxidizer to the groundwater;
- Monitoring of groundwater for reduction in COC concentrations;
- Follow up distribution of oxidizer to groundwater, as necessary to achieve PRGs; and
- Annual long-term groundwater monitoring.

Under this alternative, the initial step will be to perform a pilot study at the site. Vendors for chemical oxidation will be asked to show how their product performs by setting up small well fields, as small as three wells, and injecting oxidizers into the groundwater. An iterative process of sampling and injections will occur to assess, which vendor's product is working well and to optimize the use of that product.

Once the pilot study is complete and after an appropriate bidding process, a vendor will be chosen for the full remedial action. A full scale well field will then be designed and installed based on the pilot study information and the plume extents. The vendor will then mobilize to the site to inject the oxidizer into the appropriate wells. The vendor will inject using a mobile, pumping truck or other temporary device. A permanent structure on-site is not anticipated to be necessary for this process. The injection will be followed by sampling events to monitor the reduction in COCs. Depending on the site conditions, concentrations of COCs, and effectiveness of the oxidizer, contaminants may be reduced to PRGs with only one treatment and completed in a few months. However, for purposes of this report it is assumed that at least two additional oxidizer injections will be required and the process will require at least two year to show contaminant reductions below the PRGs.

After the oxidizer injection events, long-term monitoring of the groundwater would be conducted annually and would continue for at least five years after the remedial action to ensure that the site does not impact groundwater further or that the concentrations of COCs do not increase above the PRGs. Target parameters for groundwater samples would encompass the COCs and constituents detected above RBCs during the remedial investigation stage. A monitoring plan will be prepared prior to the implementation of site monitoring that will specify monitoring locations and list the target parameters.

ALTERNATIVE 3 - IN SITU BIOREMEDIATION OF GROUNDWATER CONTAMINATION

This alternative includes the following steps:

- Pilot Study to determine type and quantity of nutrients/substrate to use, optimize well spacing, and refine delivery methods for nutrients/substrate;
- Installation of a well field;
- Initial remedial action, the distribution of nutrients/substrate to the groundwater;
- Monitoring of groundwater for reduction in COC concentrations;
- Follow up distribution of nutrients/substrate to groundwater, as necessary to achieve PRGs; and
- Annual long-term groundwater monitoring.

Under this alternative, the initial step will be to perform a pilot study at the site. Vendors for bioremediation will be asked to show how their product performs by setting up small well fields, as small as three wells, and injecting nutrients/substrates into the groundwater. An iterative process of sampling and injections will occur to assess which vendor's product is working well and to optimize the use of that product.

Once the pilot study is complete and after an appropriate bidding process, a vendor will be chosen for the full remedial action. A full scale well field will then be designed and installed based on the pilot study information and the plume extents. The vendor will then mobilize to the site to inject the nutrients/substrate into the appropriate wells. The vendor will inject using a mobile, pumping truck or other temporary device. A permanent structure on-site is not anticipated to be necessary for this process. The injection will be followed by sampling events to monitor the reduction in COCs. Depending on the site conditions, concentrations of COCs, and effectiveness of the nutrients/substrates to stimulate microbial activities, contaminants may be reduced to PRGs within a year months after a few treatments. For purposes of this report it is assumed that at least five total injections will be required and the process will require at least four years to show reductions to the PRGs.

After the injection events, long-term monitoring of the groundwater would be conducted annually and would continue for at least five years after the remedial action to ensure that the site does not impact groundwater further or that the concentrations of COCs do not increase above the PRGs. Target parameters for groundwater samples would encompass the COCs and constituents detected above RBCs during the remedial investigation stage. A monitoring plan will be prepared prior to the implementation of site monitoring that will specify monitoring locations and list the target parameters.

4.4 ALTERNATIVE 4 - GROUNDWATER PUMPING TO EX SITU AIR STRIPPING WITH A FLARE SYSTEM FOR OFF-GAS DESTRUCTION

This alternative includes the following steps:

- Pumping tests to determine optimum well spacing and to estimate quantity of groundwater that will be extracted over time;
- Design ex situ treatment train including sizing air stripper and flare system based on groundwater quantity estimate and contaminant concentrations;
- Install well field and piping;
- Construct housing for pumping equipment and air stripper;
- Install pumping equipment, air stripper, and flare system;
- Begin pumping groundwater;
- Monitor influent groundwater to treatment train and influent/effluent gas from flare system;
- Discharge effluent to sanitary sewer, monitor effluent as required by HRSD; and
- Annual long-term groundwater monitoring to establish when PRGs have been met.

Before implementation of the full remedial action, pumping tests will be performed on existing wells to estimate the radius of influence of each well and the production of the wells in a well field. A design will then be completed to establish the location of pumping wells and the treatment train. The design would also include the sizing of the pumps, air stripper, and flare system for use at the site.

The implementation of the design would then be bid to an environmental construction firm. The selected firm would install the well field, piping system, pumps, and components of the treatment train (including the housing). The installation of this remedial action alternative would require continuing coordination with the site's personnel to avoid hampering operations at the site. Once the system is in-place, pumping of contaminated groundwater would commence. The system will require periodic maintenance and monitoring to keep components in working order and effective. Influents and effluents will need to be sampled to evaluate the efficiency of the system and keep the discharges within permitted limits. Changes in the system will be required if the system is found to be deficient. Also, an operator will need to make periodic checks of the equipment to guard against breakdown, fouling, or leaks.

It is estimated that the system will be in continuous operation for a period of 12 years before PRGs are reached. Long-term monitoring of the groundwater would be conducted at least annually during this period and would continue for possibly another five years after the remedial action is completed to ensure that the site does not impact groundwater further or that the concentrations of COCs do not increase above the PRGs. Target parameters for groundwater samples would encompass the COCs and constituents detected above RBCs during the remedial investigation stage. A monitoring plan will be prepared prior to the implementation of site monitoring that will specify monitoring locations and list the target parameters.

Section 5
DETAILED ANALYSIS OF ALTERNATIVES

In this section, the Remedial Action Alternatives that were developed in Section 4 are evaluated against nine criteria identified in the NCP and how well they meet the RAOs described in Section 2. Remedial alternatives have been developed in an effort to distinguish a cost-effective remedial action that is protective of human health and the environment and can be implemented with conventional means.

5.1 EVALUATION CRITERIA

The remedial alternatives will be evaluated against nine criteria as defined in the NCP. The first seven criteria are addressed in this FS. The last two criteria (state and community acceptance) will be addressed in the Record of Decision (ROD). The nine criteria are provided below.

- Protection of human health and the environment;
- Compliance with ARARs;
- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, and volume;
- Short-term effectiveness;
- Implementability;
- Cost;
- State acceptance; and
- Community acceptance.

The detailed alternative analysis is the method for assembling and evaluating technical and policy considerations to develop the rationale for selecting a remedy. The following paragraphs define each of the nine criteria.

5.1.1 Overall Protection of Human Health and Environment

This evaluation criterion is an assessment of whether each alternative achieves and maintains adequate protection of human health and the environment. The overall appraisal of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Another consideration is the statutory preference for on-site remedial actions.

5.1.2 Compliance with ARARs

This evaluation criterion is used to determine whether an alternative would meet all federal, state, and local ARARs that have been previously identified. Significant ARARs will be identified for each alternative, and descriptions on how they are met will be provided. When an ARAR is not met, the basis for justifying one of the six waivers allowed under CERCLA will be discussed. A discussion of the compliance of each alternative with chemical-, location-, and action-specific ARARs is included.

5.1.3 Long-Term Effectiveness and Permanence

Under this criterion the results of a remedial action alternative are evaluated in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the actions or controls that may be required to manage the risk posed by treatment residuals or untreated wastes. Factors to be considered and addressed are magnitude of residual risk, adequacy of controls, and reliability of controls. Magnitude of residual risk is the assessment of the risk remaining from untreated waste or treatment residuals after remediation. Adequacy and reliability of controls is the evaluation of the controls that can be used to manage treatment residuals or untreated wastes that remain at the facility. The evaluation may include an assessment of containment systems and institutional controls to determine whether they are sufficient to ensure that any exposure to human and environmental receptors is within protective levels.

5.1.4 Reduction of Toxicity, Mobility, and Volume

This evaluation criterion addresses the statutory preference for selecting remedial actions that use, as their principal element, technologies to permanently treat and significantly reduce the toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction of contaminant mobility, or reduction of total volume of contaminated media. When evaluating this criterion, an assessment is made as to whether treatment is used to reduce principal threats, including the extent to which toxicity, mobility, or volume are reduced either separately or in combination with one another. Critical factors include the following:

- Treatment processes employed by the remedy.
- Amount of hazardous materials to be treated.
- Degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction.
- Degree to which the treatment would be irreversible.
- Type and quantity of treatment residuals that would remain following treatment.
- Whether the alternative would satisfy the statutory preference for treatment as a principal element.

5.1.5 Short-Term Effectiveness

This evaluation criterion addresses the effects of the alternative during the construction and implementation phase until remedial action objectives are met. Alternatives would be evaluated with respect to their effects on human health and the environment during implementation of the remedial action. The following factors would be addressed for each alternative:

- Protection of the community during remedial actions.
- Protection of workers during remedial actions.
- Environmental impact during remedial actions.
- Amount of time to achieve remedial objectives.
- Air quality impacts to surrounding receptors resulting from remedial action.

5.1.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of executing an alternative and the availability of various services and materials required during its implementation. Technical feasibility includes construction, operation, reliability of technology, ease of undertaking additional remedial action, and monitoring. Administrative feasibility refers to the activities needed to coordinate with other government offices and agencies. Availability of services and materials includes availability of adequate off-facility treatment, storage capacity, and disposal services; necessary equipment and specialists; services and materials; and prospective technologies.

5.1.7 Cost

For the detailed cost analysis of alternatives, the expenditures required to complete each measure are estimated in terms both of capital and annual operation and maintenance (O&M) costs. Given these values, a present-worth calculation for each alternative can be made for comparison.

Capital costs consist of direct and indirect costs. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses, license or permit costs, and contingency allowances.

Annual O&M costs are the post-construction costs required to ensure the continued effectiveness of the remedial action. Components of annual O&M cost include the cost of operating labor, maintenance materials and labor, auxiliary materials and energy, residue disposal, purchased services, administration, insurance, taxes, licensing, maintenance reserve and contingency funds, rehabilitation, monitoring, and periodic site reviews.

Expenditures that occur over different time periods were analyzed using present worth, which discounts all future costs to a common base year. Present-worth analysis allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the remedial project. Assumptions associated with the present-worth calculations include a discount rate of 3 percent before taxes and after inflation, cost estimates in the planning years in constant dollars, and a period of performance that would vary depending on the activity, but would not exceed 30 years.

The cost estimates for this section are provided to an accuracy of +50 percent to -30 percent. The alternative cost estimates are in 2002 dollars and are based on conceptual design from information available at the time of this study. The actual cost of the project would depend on the final scope and design of the selected remedial action, the schedule of implementation, competitive market conditions, and other variables. Most of these factors are not expected to affect the relative cost differences between alternatives.

5.1.8 State Acceptance

This assessment evaluates the technical and administrative issues and concerns the state may have regarding each of the alternatives. This criterion is not discussed in this report, but would be addressed in the ROD once comments on the RI/FS have been received.

5.1.9 Community Acceptance

This assessment evaluates the issues and concerns the public may have regarding each of the alternatives. As with state acceptance, this criterion is not discussed in this report, but would be addressed in the ROD once comments on the RI/FS have been received.

5.2 INDIVIDUAL DETAILED ANALYSES

Four alternatives, including the no action alternative, will be evaluated in depth for the criteria discussed in Section 5.1.

5.2.1 Alternative 1 - No Action

Under this alternative, no further effort or resources would be expended at the site. Because contaminated media would be left on the site, a review of the site conditions would be required every 5 years. The review is specified in the NCP. *Alternative 1* serves as the baseline against which the effectiveness of other alternatives are judged. This alternative is required under the NCP. **Table 5-1** presents a summary of *Alternative 1* evaluated against the seven criteria presented below.

5.2.1.1 Overall Protection of Human Health and the Environment

Implementation of *Alternative 1* would not provide protection of human health or the environment. The toxicity, mobility, and volume of contaminants would not be reduced or eliminated. The risk of potential exposure would continue for human receptors. Any migration of contamination from the site through groundwater would continue. Residual risks are assumed identical to those identified in the baseline risk assessment, though some level of natural attenuation of the risks may occur.

5.2.1.2 Compliance with ARARs

Chemical-specific ARARs. The chemical-specific ARARs are related to contaminant levels in the groundwater, such as the MCLs. These ARARs are not meet by Alternative 1, since contaminants would remain at concentrations above the maximum levels. Also, this alternative would not meet "To-Be-Considered" guidance values, as no remedial action would be taken.

Location-specific ARARs. No location specific ARARs were identified for the site.

Action-specific ARARs. No action is taken in this alternative, therefore these ARARs are not applicable.

5.2.1.3 Long-Term Effectiveness and Permanence

Alternative 1 does not provide long-term effectiveness and permanence as the risks currently associated with the site would not be decreased and could potentially increase through migration of contaminants. Long-term risks posed by the site are described in the baseline risk assessment. Because of contaminants left at the site, a review of site conditions would be required every 5 years.

5.2.1.4 Reduction of Toxicity, Mobility, and Volume

This alternative does not provide any reduction of toxicity, mobility, and volume of the contaminants and does not meet the statutory preference for treatment.

5.2.1.5 Short-Term Effectiveness

Because no action would occur under this alternative, the level of risk to human health and the environment is described in the baseline risk assessment. No increased risk to the surrounding community would be realized by implementation of this alternative.

5.2.1.6 Implementability

This alternative does not have a monitoring or construction component associated with it. Therefore, there are no issues concerning implementation.

5.2.1.7 Cost

Taking no action would require no expenditure of money for capital purposes. As part of the 5-year review process, sampling of environmental media may be required as well as preparation of a report detailing the risk associated with the site. However, these costs would be minimal in comparison to any other alternatives, therefore they have not been included in this FS.

5.2.2 Alternative 2 - In Situ Chemical Oxidation Of Groundwater Contamination

This alternative consists of treating the groundwater in-place with chemical oxidation. Monitoring of the groundwater will continue until the site is closed.

Table 5-1 presents a summary of *Alternative 2* evaluated against the seven criteria presented below.

5.2.2.1 Overall Protection of Human Health and the Environment

Implementation of *Alternative 2* would provide protection of human health and the environment. The toxicity and volume of contaminants would be reduced or eliminated. The risk of potential exposure would decrease for potential residents using the shallow groundwater as a potable water source. The potential for contamination to migrate off-site would be reduced or eliminated. PRGs can be meet by this alternative.

5.2.2.2 Compliance with ARARs

Chemical-specific ARARs. The chemical-specific ARARs are related to contaminant levels in the groundwater, such as the MCLs. These ARARs can be meet by Alternative 2, since the concentrations of COCs would be reduced to levels within the PRGs. The PRGs are based on the MCLs or risk-based concentrations. As noted in Section 2, this alternative would not meet "To-Be-Considered" guidance values for inorganics.

Location-specific ARARs. No location specific ARARs were identified for the site.

Action-specific ARARs. The actions taken under this alternative would be governed under OSHA regulations. Workers involved in the installation of wells and inject of the oxidizers will be required to follow these regulations and follow site-specific health and safety plans. Due to the reactive nature of the oxidizers, transportation regulations will as be followed.

5.2.2.3 Long-Term Effectiveness and Permanence

Alternative 2 provides long-term effectiveness and permanence, as the potential risks to future residents would be decreased. Monitoring of the groundwater would be completed at least annually to assess the permanence of the remedy and the site will be reviewed every 5 years until the site is closed.

5.2.2.4 Reduction of Toxicity, Mobility, and Volume

This alternative reduces toxicity, mobility, and volume of the contaminants, and does meet the statutory preference for treatment.

5.2.2.5 Short-Term Effectiveness

The minimum amount of construction required for this alternative will not increase hazards to site workers. The use of oxidizers may cause a risk to site workers, due to the oxidizers reactive nature; however this risk will only be associated when the material is on-site (typically only a week) and these risks can be mitigated by proper handling of the oxidizers under OSHA, DOT, and industry standards. Well field construction would require two or three weeks. The initial addition of oxidant may take a week to two weeks; additional oxidant injections would be performed on an as needed basis and would probably require less than a week for each treatment.

There are no risks to the surrounding community or environment, because the oxidizers react to create innocuous materials, such as water, found naturally.

5.2.2.6 Implementability

This criterion considers factors, where appropriate, such as technical feasibility, administrative feasibility, and availability of services and materials.

Alternative 2 would be technically feasible. To further access the implementability of this alternative, a groundwater pilot study was conducted in 2004 to access the oxidation potential in the groundwater at the site. Malcolm Pirnie contracted with In-Situ Oxidative Technologies, Inc. (ISOTEC) to perform the $NaMnO_4$ injections throughout the course of the Pilot Study. The Groundwater Pilot Study Report is provided in **Appendix D** of this document. In summary, based on the results of the chloride, iron, and COC analysis, it was determined that injection of an 8% solution of sodium permanganate was sufficient to oxidize the groundwater contaminants at the site. However, a higher concentration of permanganate may be necessary to destroy the residual COCs at the site due to their relatively low concentration (less than 100 ug/L).

Once the pilot study is completed, a well field would be installed using standard drilling techniques. Drilling on environmental sites is a fully developed and reliable method for accessing groundwater and can be done while preventing on-site exposure and off-site migration of impacted media. The injection of oxidizer is typically completed using mobile equipment that moves from well to well. Oxidation would be monitored by collecting and analyzing groundwater samples that would then be compared against chemical-specific ARARs to determine oxidation effectiveness. Monitoring of COCs in groundwater is a reliable technology, and is a sufficient method to document the success of the remedial action. This alternative would not inhibit further remedial actions, if they should become required or appropriate.

The implementation of this alternative would require minor coordination with site personnel and utility clearers to ensure the alternative's success. The clearance of utilities would keep drilling operations away from buried infrastructure. Keeping site personnel informed of the schedule would keep operations from interfering with the site's mission and allow operations to run without interruptions.

Alternative 2 would be administratively feasible. In situ chemical oxidation is a technology that both EPA and DEQ are familiar with and have approved in the past. Since there are not discharges or effluents from the process, permits are not required.

Materials, equipment, and services required to implement this alternative are readily available. There are numerous local drilling firms available for well installation. Also, there are numerous vendors that specialize or offer chemical oxidation services with a variety of oxidizers. These firms have presences in the area and are available to mobilize to the site. Sampling and analytical services to perform monitoring are available through local consulting firms and laboratories.

5.2.2.7 Cost

The estimated capital cost of Alternative 2 is $447,000. These costs include construction of a well field and the initial injection of oxidant. This estimate is based on unit price data from RS Means Cost Data and engineering judgment from past work experience.

Operation and maintenance (O&M) costs are anticipated for two additional injection of oxidant. Annual groundwater monitoring is not included in the estimate, since monitoring will be required for all alternatives. O&M is estimated at a cost of $96,000 annually (present day dollars assumed).

The estimated present net worth of Alternative 2 is $631,000. The Alternative 2 project costs are included in **Table 5-1**. Detailed costs for Alternative 2 are presented in **Appendix B**.

5.2.3 Alternative 3 - In Situ Bioremediation of Groundwater Contamination

This alternative consists of treating the groundwater in-place by adding nutrients/substrates to the groundwater in order to promote microbial growth and the subsequent biodegradation of site COCs. Monitoring of the groundwater will continue until the site is closed.

Table 5-1 presents a summary of *Alternative 3* evaluated against the seven criteria presented below.

5.2.3.1 Overall Protection of Human Health and the Environment

Implementation of Alternative 3 would provide protection of human health and the environment. The toxicity and volume of contaminants would be reduced or eliminated. The risk of potential exposure would decrease for potential, future residents using the shallow groundwater as a potable water source. The potential for contamination to migrate off-site would be reduced or eliminated. PRGs can be meet by this alternative.

5.2.3.2 Compliance with ARARs

Chemical-specific ARARs. The chemical-specific ARARs are related to contaminant levels in the groundwater, such as the MCLs. These ARARs can be meet by Alternative 3, since the concentrations of COCs would be reduced to levels within the PRGs. The PRGs are based on the MCLs or risk-based concentrations. As noted in Section 2, this alternative would not meet "To-Be-Considered" guidance values for inorganics.

Location-specific ARARs. No location specific ARARs were identified for the site.

Action-specific ARARs. The actions taken under this alternative would be governed under OSHA regulations. Workers involved in the installation of wells and inject of the nutrients/substrates will be required to follow these regulations and follow site-specific health and safety plans.

5.2.3.3 Long-Term Effectiveness and Permanence

Alternative 3 provides both long-term effectiveness and permanence and the risks currently associated with the contaminated media would be reduced. Long-term risks posed by the site are described in the baseline risk assessment. The majority of contamination would be eliminated from the groundwater. Regular monitoring of groundwater would be completed at least annually and the site would be reviewed every 5 years until closed.

5.2.3.4 Reduction of Toxicity, Mobility, and Volume

This alternative reduces toxicity, mobility, and volume of the contaminants, and does meet the statutory preference for treatment.

5.2.3.5 Short-Term Effectiveness

The minimum amount of construction required for this alternative will not increase hazards to site workers. The chemicals used in this process, such as molasses, are typically innocuous, so no hazards should be associated with them. Workers associated with the remedial action will be protected from construction hazards by adhering to the site-specific health and safety plans and wearing required personal protection equipment.

Well field construction would require two or three weeks. The initial addition of nutrients/substrates may take a week to two weeks; additional injections would be performed on an as needed basis and would probably require less than a week for each treatment.

There are no risks to the surrounding community or environment, because this alternative only enhances an on-going natural process using generally innocuous materials in situ.

5.2.3.6 Implementability

This criterion considers factors, where appropriate, such as technical feasibility, administrative feasibility, and availability of services and materials.

Alternative 3 would be technically feasible. To implement this alternative a pilot study would be required to optimize the process. Once the pilot study is completed, a well field would be installed using standard drilling techniques. Drilling on environmental sites is a fully developed and reliable method for accessing groundwater and can be done while preventing on-site exposure and off-site migration of impacted media. The addition of nutrients/substrates is typically completed using mobile equipment that moves from well to well. The process would be monitored by collecting and analyzing groundwater samples that would then be compared against chemical-specific ARARs to determine process effectiveness. Monitoring of COCs in groundwater is a reliable technology, and is a sufficient method to document the success of the remedial action. This alternative would not inhibit further remedial actions, if they should become required or appropriate.

The implementation of this alternative would require minor coordination with site personnel and utility clearers to ensure the alternative's success. The clearance of utilities would keep drilling operations away from buried infrastructure. Keeping site personnel informed of the schedule would keep operations from interfering with the site's mission and allow operations to run without interruptions.

Alternative 3 would be administratively feasible. In situ bioremediation is a technology that both EPA and DEQ are familiar with and have approved in the past. Since there are not discharges or effluents from the process, permits are not required.

Materials, equipment, and services required to implement this alternative are readily available. There are numerous local drilling firms available for well installation. Also, there are numerous vendors that specialize or offer bioremediation services with a variety of nutrients/substrates. These firms have presences in the area and are available to mobilize to the site. Sampling and analytical services to perform monitoring are available through local consulting firms and laboratories.

5.2.3.7 Cost

The estimated capital cost of Alternative 3 is $496,000. These costs include construction of a well field and the initial injection of nutrient/substrate. This estimate is based on unit price data from RS Means Cost Data and engineering judgment from past work experience.

Operation and maintenance (O&M) costs are anticipated for four additional injections of nutrients/substrate. Annual groundwater monitoring is not included in the estimate, since monitoring will be required for all alternatives; however, the additional cost of monitoring biodegradation parameters has been included. O&M is estimated at a cost of $99,000 annually (present day dollars assumed).

The estimated present net worth of Alternative 3 is $864,000. The Alternative 3 project costs are included in **Table 5-1**. Detailed costs for Alternative 3 are presented in **Appendix B**.

5.2.4 Alternative 4 - Groundwater Pumping to Ex Situ Air Stripping with a Flare System for Off-Gas Destruction

This alternative consists of pumping groundwater to a treatment train composed of an air stripper and flare system. Effluent water from the system is disposed of in the sanitary sewer system and off gases from the flare system are released to the atmosphere. The groundwater influent, air emissions, and effluent water will be monitored for system performance.

Table 5-1 presents a summary of Alternative 4 evaluated against the seven criteria presented below.

5.2.4.1 Overall Protection of Human Health and the Environment

Implementation of Alternative 4 would provide protection of human health and the environment. The toxicity and volume of contaminants would be reduced or eliminated. The risk of potential exposure would decrease for potential, future residents using the shallow groundwater as a potable water source. The potential for contamination to migrate off-site would be reduced or eliminated. PRGs can be meet by this alternative.

5.2.4.2 Compliance with ARARs

Chemical-specific ARARs. The chemical-specific ARARs are related to contaminant levels in the groundwater, such as the MCLs. These ARARs can be meet by Alternative 4, since the concentrations of COCs would be reduced to levels within the PRGs. The PRGs are based on the MCLs or risk-based concentrations. As noted in Section 2, this alternative would not meet "To-Be-Considered" guidance values for inorganics.

Location-specific ARARs. No location specific ARARs were identified for the site.

Action-specific ARARs. Action specific ARARs under this alternative include OSHA requirements, erosion control requirements, as well as disposal of off-gases and effluent water from the treatment train. Work completed at the site will be performed in accordance with site-specific health and safety plans and OSHA regulations. Erosion controls will be maintained as required in the Virginia Erosion and Sediment Control Regulations. Compliance with air pollution regulations and effluent permit requirements from HRSD will be monitored with periodic sampling.

5.2.4.3 Long-Term Effectiveness and Permanence

Alternative 4 provides both long-term effectiveness and permanence and the risks currently associated with the contaminated media would be reduced. Long-term risks posed by the site are described in the baseline risk assessment. The majority of contamination would be eliminated from the groundwater. Regular monitoring of groundwater would be completed at least annually and the site would be reviewed every 5 years until closed.

5.2.4.4 Reduction of Toxicity, Mobility, and Volume

This alternative reduces toxicity, mobility, and volume of the contaminants, and does meet the statutory preference for treatment.

5.2.4.5 Short-Term Effectiveness

The degree of construction required for this alternative may possess small hazards to site workers. Heavy construction, such as excavators and forklifts will be required to complete parts of the construction. Delivery of materials will also increase truck traffic at the site. Both construction equipment and delivery trucks will increase transportation risks and noise hazards at the site.

Workers associated with the remedial action will also be exposed to these risks and risks associated with small building construction and excavations. Overall, these risks can be minimized by informing site workers of restricted areas and traffic patterns and having remedial action workers adhere to the site-specific health and safety plans.

Well field construction would require two or three weeks. A month to two months will be required to install piping, construct the treatment train housing, and install the treatment train components. Pumping will be virtually continuous from the end of the construction phase until the PRGs are meet. Site workers and the personnel maintaining the system will be exposed to risks associated with the flare system, including high temperatures and the use of petroleum fuels. As noted above, these risks can be minimized by informing site workers of restricted areas and having maintenance workers adhere to the site-specific health and safety plans.

There are no risks to the surrounding community or environment, if the process is maintained properly. However, there could be leaks in the piping causing spills of contaminated groundwater and if the flare is not working properly there may be undesirable levels of COCs released to the air. Periodic maintenance and monitoring of the pumping and treatment train components would minimize these risks.

5.2.4.6 Implementability

This criterion considers factors, where appropriate, such as technical feasibility, administrative feasibility, and availability of services and materials.

Alternative 4 would be technically feasible. To implement this alternative a pumping study would be required to optimize the process. This would be performed on existing wells using standard methods to measure flow rate into the wells. Once the pumping study is completed, a well field would be installed using standard drilling techniques. Drilling on environmental sites is a fully developed and reliable method for accessing groundwater and can be done while preventing on-site exposure and off-site migration of impacted media. The installation of piping would require adequate knowledge of the buried infrastructure at the site to avoid damaging existing lines. The buried pipe at the site should be easily located using conventional utility location methods and the existing pipes are not closely packed, so avoiding pipes altogether may be possible. Also, the major of lines to be installed will be pressurized so maintaining pipe slope is not critical. Air strippers, flare systems, pump equipment, and pre-fabricated structures are all readily available from numerous vendors. Most contractors using conventional methods can handle the installation of these components. There are a number of contractors with environmental expertise in the area that should familiar with the installation of similar pump and treat systems. Though periodic maintenance of the system will be required once installed, many of the environmental contractors in the region offer this type of service. Also, site workers or other Fort Story personnel could be readily and easily trained to inspect and repair the system as necessary. This alternative would not inhibit further remedial actions, if they should become required or appropriate.

There will be a need for periodic monitoring of the groundwater and effluents from the system. Monitoring of COCs in groundwater and constituents in air and water discharges are reliable technologies, and standard methods can be used to document the success of the remedial action and compliance of the effluents with any needed permits.

The implementation of this alternative would require a high degree of coordination with site personnel to ensure the alternative's success. Excavation activities may cut through heavily traveled areas, thus site workers will need to be informed of the timing of such activities and alternative traffic patterns devised. Also, the placement of the treatment train will need to be coordinated to avoid loss of work areas for an extended period (probably years) and to avoid areas heavily traveled by site workers. The effects of this alternative on the site's mission can be minimized by having base personnel involved in the design phase and maintaining communication between the contractor and site workers.

Alternative 4 would be administratively feasible. Permitting for the air emissions from the flare and effluent from the air stripper may be required. During the design phase, the quantities of contaminants volatilized and the amount of reduction expected by the flare system will have to be evaluated. With these parameters, the design firm in conjunction with the regulatory agencies can assess the need for an air emissions permit and, if necessary, the type of permit required. Similarly, the quantities of contaminants remaining in the treated water will be assess during the design phase in order to assess the permitting requirements for discharging to HRSD's wastewater treatment plant.

Materials, equipment, and services required to implement this alternative are readily available. There are numerous local drilling firms available for well installation. Also, there are numerous contractors capable of installing and maintaining a pump and treat system. Sampling and analytical services to perform monitoring are available through local consulting firms and laboratories.

5.2.4.7 Cost

The estimated capital cost of Alternative 4 is $548,000. These costs include installation of a well field, piping, air stripper, flare system, pump equipment, and electrical system. This estimate is based unit price data from RS Means Cost Data and engineering judgment based on past work experience at the site.

Estimated operation and maintenance costs for this alternative are based on monitoring of the system weekly and periodic repair of equipment. Annual groundwater monitoring is not included in the estimate, since monitoring will be required for all alternatives; however, the additional cost of monitoring influents/effluents has been included. O&M costs are estimated at $46,000 annually (present day dollars assumed). It is anticipated that the system will be in operation for 12 years.

The estimated present net worth of Alternative 4 is $1,009,000. The Alternative 4 project costs are included in **Table 5-1**. Detailed costs for Alternative 4 are presented in **Appendix B**.

The Remedial Action Alternatives were evaluated against seven of the nine criteria identified in the NCP. The two remaining criteria will be evaluated during development of the Decision Document.

6.1 COMPARATIVE ANALYSES OF REMEDIAL ALTERNATIVES

In the following analysis, the remedial alternatives are evaluated in relation to one another for each of the seven criteria evaluated in Section 5. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative. **Table 6-1** contains a summary of this analysis. The remedial alternatives are listed below for clarification of this discussion:

- **Alternative 1** - ***No Action***
- **Alternative 2** – ***In Situ Chemical Oxidation Of Groundwater Contamination***
- **Alternative 3** – ***In Situ Bioremediation of Groundwater Contamination***
- **Alternative 4** – ***Groundwater Pumping to Ex Situ Air Stripping with a Flare System for Off-Gas Destruction***

6.1.1 Protection of Human Health and Environment

Alternatives 2, 3, and 4 are preferable and will provide adequate protection of human health and the environment from the short-term and long-term risks as the impacted groundwater will be treated to reduce risks. Alternatives 1 will not protect human health and the environment. This is a determining criterion, and alternatives that do not meet this criterion cannot be selected. Therefore, Alternative 1 cannot be selected.

6.1.2 Compliance with ARARs

Alternatives 2, 3, and 4 are expected to comply with the applicable potential ARARs summarized in **Tables 2-1** and **2-2**. However, the ability of Alternatives 2 and 3 to comply with SDWA criteria for underground injection requirements will depend on obtaining approval from DEQ/EPA. The ability of Alternatives 4 to comply with discharge-related ARARs will depend upon obtaining approval from HRSD to discharge liquid from the air stripper into the existing sanitary sewer.

Alternatives 1 will not be able to comply with ARARs because the media is already contaminated above cleanup criteria. Because compliance with ARARs is a threshold criterion, Alternatives 1 will not be selected.

6.1.3 Long-Term Effectiveness and Permanence

This criterion assesses long term effectiveness of an alternative. Alternatives 2, 3, and 4 provide the greatest long-term effectiveness, because the impacted groundwater will be treated. However, as impacted groundwater will not be treated or removed, Alternative 1 has a lower rating than Alternatives 2, 3, and 4.

6.1.4 Reduction of Toxicity, Mobility, and Volume

This evaluation criterion assesses the degree to which an alternative employs recycling or treatment that reduces toxicity, mobility, or volume. This criterion reflects the statutory preference for treatment of contamination. Alternatives 2, 3, and 4 meet this criterion best, because they include treatment. Alternatives 1 does not reduce toxicity, mobility, and volume, and therefore is not preferable.

6.1.5 Short-Term Effectiveness

This criterion assesses the short-term impacts on the alternative. Alternatives 1 is most preferable under this criterion, as it will not have short-term impacts. Alternatives 2, 3, and 4 are less preferable as they have minor short-term impacts during implementation, but these impacts can be addressed by common work practices, safety measures, and dust control measures.

6.1.6 Implementability

This evaluation criterion assesses the ease or difficulty of implementing the alternative. All of the alternatives are implementable. However, Alternatives 2, 3, and 4 are less preferable (than Alternatives 1) as they are contingent upon obtaining appropriate approvals for underground injection or discharge of vapors/liquids from the ex situ treatment system.

6.1.7 Cost

Alternatives 1 is not considered with respect to this criterion because it was eliminated earlier. Therefore, only Alternatives 2, 3, and 4 are considered with respect to the cost criterion. Alternative 2 is the least costly of the available alternatives with a present net worth (PNM) of $631,000. Alternative 3 has a PNW of approximately $864,000. Alternative 4 has a PNW of approximately $1,009,000. Based on ranking by PNW, Alternative 2 is the preferable alternative.

6.1.8 State and Community Acceptance

As noted in Section 5, state and community acceptances are not evaluated in this FS. State acceptance will be addressed by Virginia Department of Environmental Quality (DEQ) review and comment on the feasibility study. Community acceptance will be addressed during subsequent actions in the remedial action process and incorporated into the ROD.

6.2 SUMMARY

Alternatives 2 and 3 appear to be the most feasible and cost effective alternatives for remediating the Site. While Alternative 4 meets the criteria, it is less preferable as it requires handling of contaminated groundwater and discharge of vapor and liquid effluents. Alternative 1 does not meet the threshold criteria, and therefore, cannot be selected. Since Alternative 2 is relatively less expensive and remediates quicker than Alternative 3, Alternative 2 is the preferred alternative. In addition, with the completion of the pilot study, Alternative 2 has been field-proven at the site as a feasible alternative for groundwater contaminant concentration reduction.

FEASIBILITY STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

FIGURE 1-3

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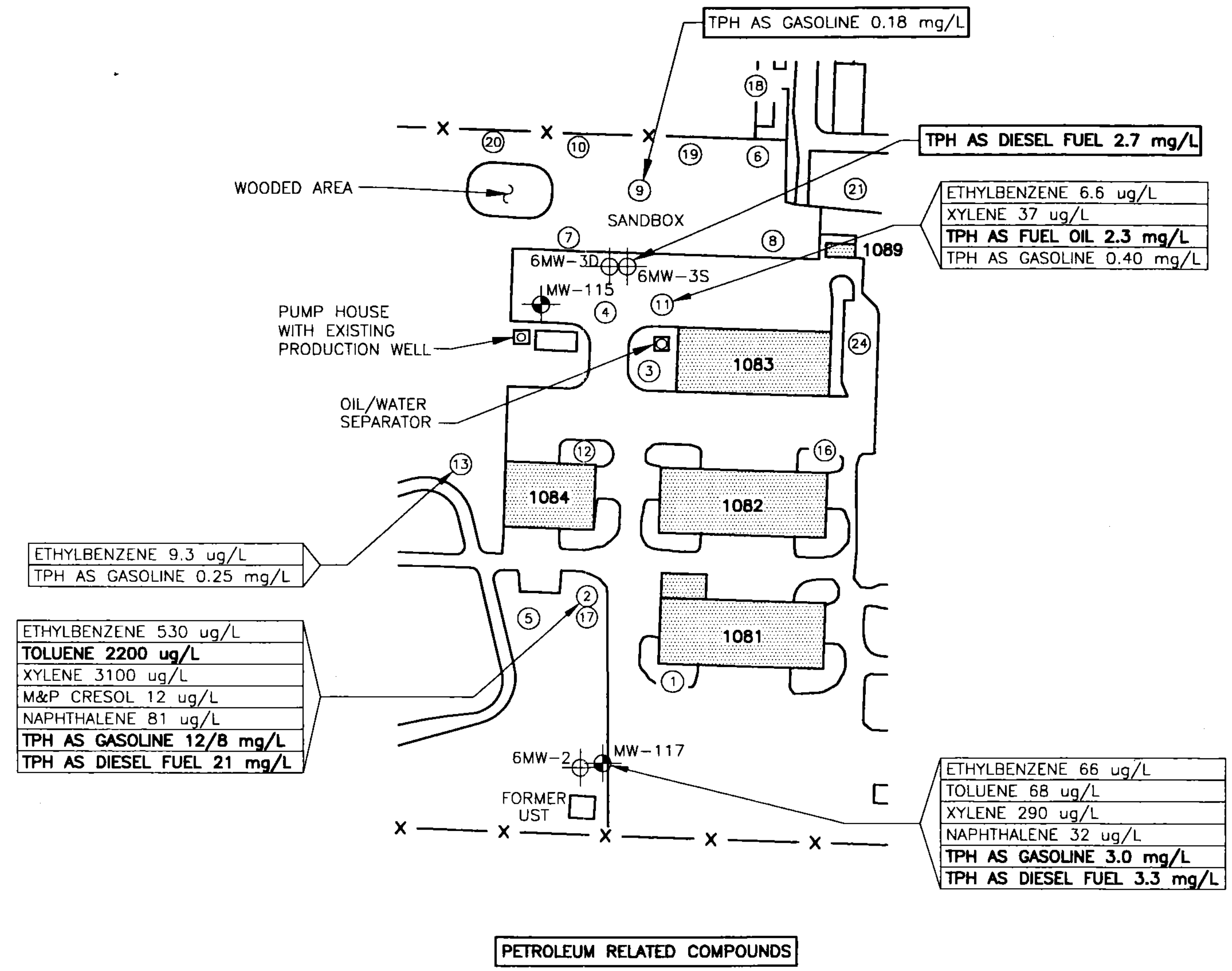

LEGEND:

- EXISTING MONITORING WELLS
- NEW WELLS
- (1) DPT GROUNDWATER POINTS

0 100 200 400

SCALE IN FEET

MALCOLM PIRNIE

FORT STORY, VIRGINIA

FEASIBILITY STUDY

LARC 60 GROUNDWATER CONCENTRATIONS ABOVE EPA SCREENING CRITERIA

MALCOLM PIRNIE, INC.

DEC 2004

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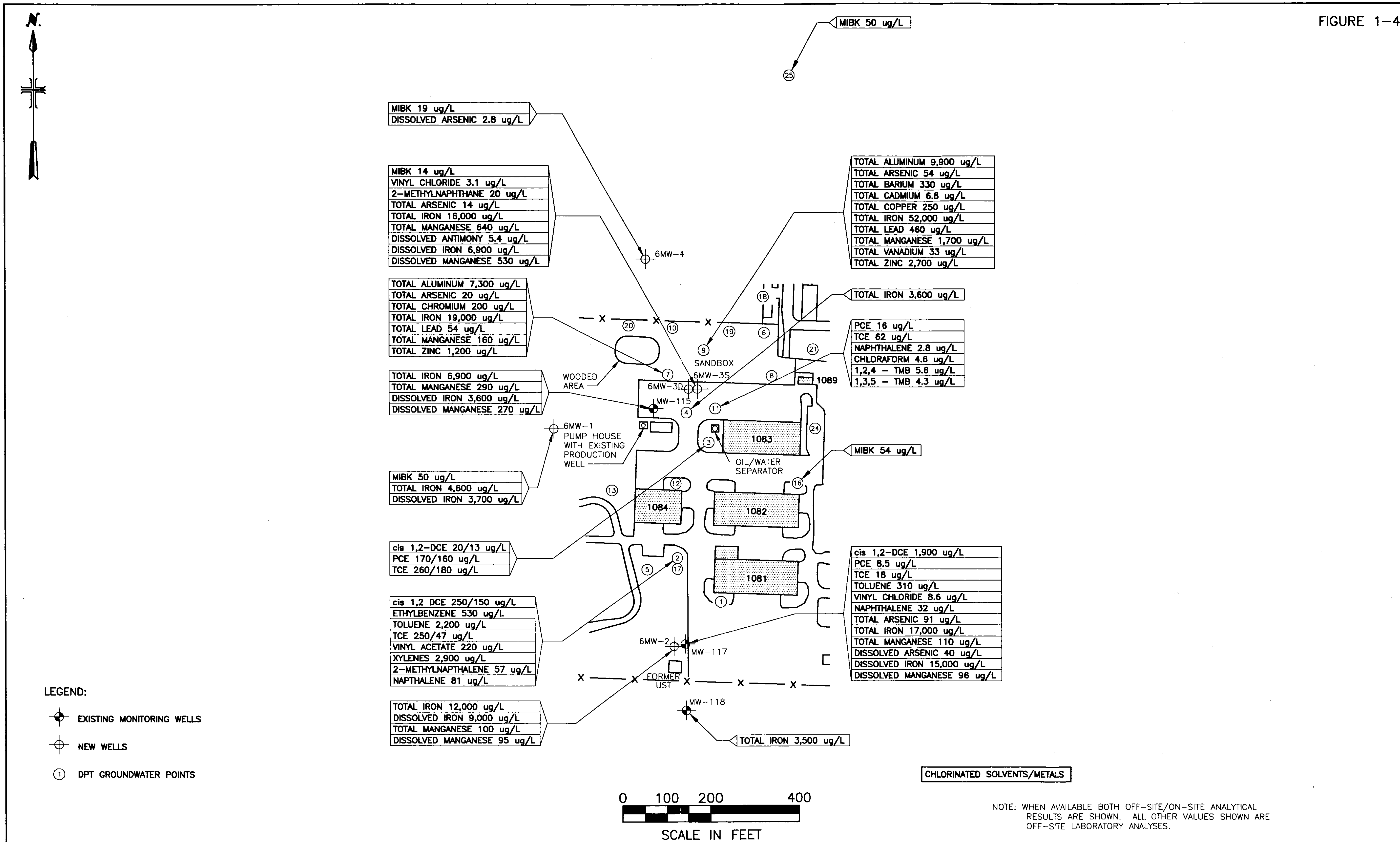


MALCOLM PIRNIE

FORT STORY, VIRGINIA

FEASIBILITY STUDY

LARC 60 GROUNDWATER CONCENTRATIONS ABOVE EPA SCREENING CRITERIA

MALCOLM PIRNIE, INC.

DEC 2004

XREFS: IMAGES:None

FEASIBILITY STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

TABLE 2-1
Preliminary Chemical-Specific ARARs
LARC 60 Maintenance Area
Fort Story, VA

Regulation or Guidance	ARAR or TBC	Applicability
EPA Region III Risk-Based Concentration Tables	TBC	Possible groundwater cleanup targets based on human exposure to COCs for residential use scenarios. For a single contaminant in a single medium, under standard default exposure assumptions, the RBC corresponds to the target risk or hazard quotient. However, the RBCs for non-carcinogens are adjusted by a factor of 0.1, in order to account for the cumulative effects of multiple contaminants.
Safe Drinking Water Act Maximum Contaminant Levels (40 CFR 141 and 143)	ARAR	MCLs exist for parameters of concern at this site and maybe applied to groundwater. Water quality should meet these standards and criteria after completion of any removal action.
Virginia Groundwater Quality Standards (9VAC25-260-10 et seq.)	ARAR	These standards may be applied directly to groundwater. Water quality should meet the enforceable standards and criteria after completion of any removal action.
Virginia DEQ Petroleum Program Manual (March 1995)	TBC	The program provides screening levels for total petroleum hydrocarbons (TPH); however, action levels are not specified. Contaminant action levels are to be site-specific and risk-based.
Virginia Groundwater Quality Criteria	TBC	These criteria are for naturally occurring substances detected in groundwater. The criteria are to be used as guidance on what contaminant levels may be considered acceptable.

TABLE 2-2
Preliminary Action-Specific ARARs
LARC 60 Maintenance Area
Fort Story, VA

Regulation or Guidance	ARAR or TBC	Applicability
National Pollution Discharge Elimination System Regulations (40 CFR 122)	ARAR	Any water from decontamination or treatment processes must meet effluent discharge standards before being discharged to surface water bodies or to the Hampton Roads Sanitation District (HRSD). Discharges to HRSD must comply with the bases' wastewater permit issued by HRSD.
Virginia Pollution Discharge Elimination System Regulations (9 VAC 25-31)	ARAR	Any water from decontamination or treatment processes must meet effluent discharge standards before being discharged to surface water bodies or to the Hampton Roads Sanitation District (HRSD). Limits for surface water discharges are set by VDEQ on a case-by-case basis. Discharges to HRSD must comply with the bases' wastewater permit issued by HRSD.
OSHA - General Industry Standards (29 CFR 1910)	ARAR	OSHA requirements for work at hazardous facilities will be implemented and followed by all involved employees.
Resource Conservation and Recovery Act (40 CFR 260 et seq.)	ARAR	Virginia has an approved RCRA program, and VHWMR will govern instead of RCRA.
Virginia Hazardous Waste Management Regulations (9 VAC 20-60)	ARAR	VHWMR will govern transport, storage, treatment, or disposal of any waste identified as hazardous in lieu of RCRA, as Virginia has an authorized RCRA program. This regulation will be applicable if the selected action results in a concentrated waste requiring disposal.
Virginia Solid Waste Management Regulations (9 VAC 20-80)	ARAR	The Virginia Solid Waste Management Regulations (9 VAC 20-80) will be an applicable ARAR if contaminated material is removed from the site for treatment and/or disposal. This regulation will govern the generation, transport, treatment and disposal of solid wastes.
Rules Governing the Transportation of Hazardous Materials (49 CFR Parts 107, 171.1 - 0.500)	ARAR	All waste haulers must be properly licensed for hauling hazardous waste and follow applicable DOT regulations. If removed from the site, any residual wastes are not expected to be classified as hazardous wastes.
Virginia Regulations for Transportation of Hazardous Materials (9 VAC 20-110)	ARAR	As described above, residual wastes from the site are not expected to be considered hazardous wastes. Analytical testing would be required of the waste product to determine if it is hazardous waste. Any transportation of hazardous materials within the Commonwealth of Virginia must meet all the requirements outlined in these regulations.
Virginia Erosion and Sediment Control Regulations (4 VAC 50-30)	ARAR	An erosion and sediment control plan may need to be prepared prior to any land disturbing activity, depending on the area of the site being disturbed. It is anticipated that any remedial actions at the site would require minimal land disturbance. The plan would be submitted to and approved by the local soil and water conservation district. This plan can act as a Pollution Prevention Plan that is

TABLE 2-2 (Continued)
Preliminary Action-Specific ARARs

Regulation or Guidance	ARAR or TBC	Applicability
		developed to reduce pollutants associated with stormwater discharge.
Clean Air Act - Air Quality Standards for Particulate Matter (40 CFR 50)	ARAR	Limits airborne particulate matter produced by construction activities. It is anticipated that construction associated with remedial action would not create significant amounts of airborne particulates matter (dust).
Virginia Regulations for the Control and Abatement of Air Pollution (9 VAC 5-10)	ARAR	Any emission from any treatment process must meet the standards for toxic pollutants, particulates and volatile organic compounds.

Table 2-3
SITE SPECIFIC PRELIMINARY REMEDIATION GOALS
EXPOSURE TO SITE GROUNDWATER
LARC 60 MAINTENANCE AREA
FORT STORY, VIRGINIA

COC	MCL-based PRG (ug/L)	Risk-based PRG (ug/L)	Site Specific PRG (ug/L)
cis 1,2-DCE	70	---	70
Naphthalene	---	2.2*	2.2
PCE	5	---	5
TCE	5	---	5
Vinyl chloride	2	---	2

Notes:
* Based on HQ = 1.0

TABLE 3-1
GENERAL RESPONSE ACTIONS AND TECHNOLOGY TYPES
LARC 60 Maintenance Area
Fort Story, VA

General Response Actions	Technology Types	Technically Implementable? - Yes/No
No Action	None	Yes
Monitoring	Monitoring	Yes
Institutional Controls	Access Restrictions	Yes
	Land Use Restrictions	Yes
Containment	Barrier Walls	Yes
	Interceptor Trench	Yes
Extraction	Dual Phase Extraction	No
	Pumping	Yes
In-situ Treatment - Chemical	Air Sparging	Yes
	Chemical Oxidation	Yes
	Reactive Treatment Walls	Yes
In-situ Treatment - Physical	Fracturing	No
	Bioslurping	No
	Soil Vapor Extraction	No
	In-well Air Stripping	Yes
In-situ Treatment - Biological	Bioremediation	Yes
In-situ Treatment - Thermal	Thermally Enhanced SVE	No
Ex-situ Treatment - Chemical	Chemical Reduction/Oxidation	Yes
	Adsorption/Absorption	No
	Air stripping	Yes
	Ion Exchange	No
	Precipitation	No
Ex-situ Treatment - Physical	Separation	Yes
	Sprinkler Irrigation	No
Ex Situ Treatment - Thermal	Flare System	Yes
	Thermal Oxidation	Yes
Ex Situ Treatment - Biological	Bioreactors	Yes
	Constructed Wetlands	No
Disposal - Groundwater	Injection to Subsurface	Yes
	Discharge to Storm Sewer	Yes
	Discharge to WWTP	Yes

TABLE 3-2
PROCESS OPTIONS EVALUATION AND SCREENING
LARC 60 Maintenance Area
Fort Story, VA

General Response Action	Technologies	Process Options	Description	Effectiveness	Implementability	Cost	Screening Comments	Retain or Reject
No Action	None	None	No action - contaminated media remains in-place.	Low	High	Low	Does not reduce toxicity, mobility or volume of contaminants except by natural attenuation. Does not reduce potential for human or ecological exposure. Retain as baseline alternative as per NCP.	**Retain**
Monitoring	Monitoring	Environmental media sampling	Long term monitoring of groundwater.	Low	High	Low	Necessary to measure effectiveness of any remedial alternative. Will be used in conjunction with other response actions. Does not reduce toxicity, mobility, or volume of contaminants. Does not reduce potential human or ecological risk.	**Retain**
Institutional Controls	Access Restrictions	Posting Signs	Post signs to restrict human exposure to wetland area /wooded area/ and ditches.	Low	High	Low	Does not reduce toxicity, mobility, or volume of contaminants. Does not reduce human or ecological risk.	Reject
		Fencing	Prevent human access to wooded area/ wetland area/ and ditches.	Low	High	Low	Does not reduce toxicity, mobility, or volume of contaminants. Does not reduce human or ecological risk.	Reject
	Land Use Restrictions	Land Use Restrictions	Restrict current and future use of the site.	Low	High	Low	Does not reduce toxicity, mobility, or volume of contaminants. Does not reduce ecological risk.	Reject
Containment	Barrier Walls	Slurry Walls	These subsurface barriers consist of vertically excavated trenches filled with a low permeable material. The material creates a hydraulic barrier to retard ground water flow.	Low	Medium	Low/Medium	Heavy construction required. Walls only contain groundwater and redirect flow; does not treat COCs. May extent plume laterally. Cost dependent on various factors.	Reject
	Interceptor Trench	Interceptor Trench	A vertical boundary of highly permeable material in which groundwater is pumped to creat a sump	Low	Medium	Medium	Heavy constructioin required. Does not treat COCs, would require ex-stiu treatment. Same effect can be achieved with well pumping	Reject
Extraction	Pumping	Pumping	Ground water pumping is a component of the pump-and-treat processes.	Medium	High	High	Does potentially reduce volume of contaminants within groundwater and retards contaminant mobility from site. Requires ex-situ treatment.	**Retain**
In-situ - Treatment	Chemical	Chemical Oxidation	Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic.	High	High	Medium	Does potentially reduce volume of COCs within groundwater. No ex-situ treatment required. Process can be implemented using simple and relatively available equipment.	**Retain**
		Reactive Treatment Walls	These barriers allow the passage of water while causing the degradation or removal of contaminants.	High	Medium	High	Heavy construction required. Does potentially reduce volume of COCs within groundwater. Hard to monitor fouling or COC breakthrough.	Reject
	Physical	Air Sparging	Air is injected into saturated matrices to remove contaminants through volatilization. SVE extracts vapors from soil.	Medium	Medium	Medium	Does potentially reduce volume of contaminants within groundwater. Requires vapor removal from soil and ex-situ treatment.	Reject
		In-well Air Stripping	Air injected into a well and VOCs are transferred to vapor by air bubbles.The air rises in the well to the water surface where vapors are drawn off and treated by a soil vapor extraction system.	Low	Low	Medium	Shallow aquifers may limit process effectiveness. Awareness of process is limited in United States	Reject
	Biological	Bioremediation	Introduction of substrates into the groundwater to promote microbe growth and subsequent destruction of COCs.	Medium	High	Medium	Does potentially reduce volume of COCs within groundwater. No ex-situ treatment required. Process can be implemented using simple and relatively available equipment.	**Retain**
Ex-situ Treatment	Chemical	Advanced Oxidation - UV, Ozone	Use agents to oxidize COCs from extracted groundwater	High	Medium	High	Process can be better controlled to more uniformly reduce contaminants. Requires site space for aboveground process. Effluent water will need to be dealt with. Energy requirements make costs higher than other technologies.	Reject
	Physical	Air Stripping	COCs volatilized to vapor state by cascading or spraying groundwater.	High	High	Medium	Proven technology widely used for site's COCs. Effluent water needs to be dealt with. Creates vapor phase contaminants that may need further treatment.	**Retain**
		Carbon Absorption	Extract contaminants are filtered through carbon. Contaminants sorb onto carbon.	Medium	High	High	Carbon is less effective on low molecular compounds, such as vinyl chloride. Effluent water needs to be dealt with. Carbon will have to be disposed of or regenarated periodically. Spent carbon may be considered hazardous depending on contaminant concentrations sorbed	Reject
		Separation	Removal of water in media.	Medium	High	Medium	Requires site space for aboveground process. The presence of oil and grease contaminants (TPH) may interfere with these processes by decreasing flow rate.	Reject
	Thermal	Flare System	Combustion of COCs in a controlled environment	High	High	Medium	Would require pretreatment so contaminants can be addressed in vapor phase. Requires additional space on site. Would require fuel source.	**Retain**
		Thermal Oxidation	Destroy contaminants at high temperatures with the use of a catalyst to achieve a high degree of COC destruction.	High	High	High	Would require pretreatment so contaminants can be addressed in vapor phase. Requires additional space on site. Would require fuel source. Requires catalyst; The presence of chlorinated hydrocarbons and some heavy metals may poison a particular catalyst.	Reject
	Biological	Bioreactors	Contaminants in extracted groundwater are put into contact with microorganisms in attached or suspended growth biological reactors	Medium	High	Medium	Bioreactors are sensitive to flucuations in contaminant levels. Sludge and effluent water must be dealt with. Nuisance odors may be a problem. Requires site space for aboveground process.	Reject
Disposal - Groundwater	Injection to subsurface	Injection to subsurface	Discharge effulent water from ex-situ treatment back to groundwater regime.	High	Low	Medium	Requires additional wells in order to inject remediated water back to subsurface. May require groundwater injection permit.	Reject
	Discharge to Storm Sewer	Discharge to Storm Sewer	Discharge effulent water from ex-situ treatment to existing stormwater conveyance system	High	Medium	Low	Site has an existing stormwater system that could be tied into. Would require a discharge permit.	Reject
	Discharge to WWTP	Discharge to WWTP	Discharge effulent water to wastewater treatment plant servicing Fort Story.	High	Medium	Medium	POTW could handle small flows of remediated water. Sanitary system exists on site. Agreement with POTW may be required.	**Retain**

TABLE 5-1
INDIVIDUAL EVALUATION OF FINAL ALTERNATIVES
LARC 60 Maintenance Area
Fort Story

Criteria	Alternative 1 No Further Action	Alternative 2 In Situ Chemical Oxidation	Alternative 3 In Situ Bioremediation	Alternative 4 Pumping w/ Air Stripping and Flare System
Protection of Human Health and the Environment	No reduction in risk.	Expected to provide protection of human health by reducing risks. No risks to the environment.	Expected to provide protection of human health by reducing risks. No risks to the environment.	Expected to provide protection of human health by reducing risks. No risks to the environment.
Compliance with ARARs	Both State and Federal groundwater ARARs (e.g. MCLs) are not meet	Chemical specific ARARs are met for groundwater. Action-specific ARARS include compliance with OSHA requirements during construction and remedial action. No location specific ARARs.	Chemical specific ARARs are met for groundwater. Action-specific ARARS include compliance with OSHA requirements during construction and remedial action. No location specific ARARs.	Chemical specific ARARs are met for groundwater. Action-specific ARARS include compliance with OSHA requirements during construction and remedial action, compliance with air pollution and water quality regulations. No location specific ARARs.
Long-Term Effectiveness	No reduction in risk.	Expected to be effective in reducing or eliminating COCs in groundwater, thus reducing human health risks.	Expected to be effective in reducing or eliminating COCs in groundwater, thus reducing human health risks.	Expected to be effective in reducing or eliminating COCs in groundwater, thus reducing human health risks.
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility, or volume of contaminated groundwater	Toxicity, mobility, and volume of contaminated groundwater are reduced.	Toxicity, mobility, and volume of contaminated groundwater are reduced.	Toxicity, mobility, and volume of contaminated groundwater are reduced.
Short-Term Effectiveness	No action taken, therefore no short-term risks	Short-term risks identified for this alternative include construction safety during drilling operations and safety in handling oxidant addition.	Short-term risks identified for this alternative include construction safety during drilling operations.	Short-term risks involved with implementation of this alternative include traffic and noise problems for Site workers; drilling, excavation, and building construction hazards for contractor.
Implementability	Fully and easily implementable since there are no corrrective action components.	This alternative would be technically and administratively feasible to implement.	This alternative would be technically and administratively feasible to implement.	This alternative would be technically and administratively feasible to implement, but coordination will be required to avoid conflicts with Site mission.
COSTS (rounded to the nearest $1K)				
Capital Cost	$0	$447,000	$496,000	$548,000
First Annual O&M Cost	$0	$96,000	$99,000	$46,000
Present Worth Cost	$0	$631,000	$864,000	$1,009,000

TABLE 6-1
SUMMARY OF ALTERNATIVES EVALUATION
LARC 60 Maintenance Area
Fort Story, VA

Evaluation Criteria	Alternative 1 No Action	Alternative 2 In Situ Chemical Oxidation	Alternative 3 In Situ Bioremediation	Alternative 4 Groundwater Pumping to Ex Situ Treatment: Air Stripping and Flare System
Overall protection of human health and the environment	No	Yes	Yes	Yes
Compliance with ARARs	No	Yes	Yes	Yes
Long-term effectiveness and permanence	No	Yes	Yes	Yes
Reduces toxicity, mobility, or volume through treatment	No	Yes	Yes	Yes
Short-term effectiveness	Yes	Yes	Yes	Yes
Implementability	NA	Yes	Yes	Yes
Cost	---	$631,000	$864,000	$1,009,000

Notes:

Yes - Alternative meets evaluation criterion

Partial - Alternative partially meets evaluation criterion

No - Alternative does not meet evaluation criterion

NA - Not applicable

FEASIBILITY STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

TABLE 2-5
SUMMARY OF LARC 60 FIELD INVESTIGATIONS

Location	Soil Borings/ Samples	Surface Soil Samples	Sediment Samples	Surface Water Samples	DPT GW Samples	Monitoring Well Samples	Monitoring Wells Installed	Temporary Well Points Sampled/Installed
1995 FIELD INVESTIGATIONS								
Former UST Area								
Upgradient of UST Area	0/0	0	0	0	0	1	0	0
UST Area	2/3	2	0	0	0	0	0	2
Downgradient of UST Area	1/1	1	0	0	7	3	2	1
OWS Area								
Upgradient of OWS	1/2	1	0	0	1	0	0	0
OWS Area	1/3	1	0	0	0	0	0	0
Downgradient of OWS	5/5	4	0	0	3	3	2	0
Sandbox Area								
Sandbox Area	10/10	10	0	0	7	0	0	0
Downgradient of Sandbox Area	3/3	3	2	2	7	1	1	0
1995 Totals	23/27	22	2	2	25	8	5	3
2000 SAMPLING EVENT								
Former UST Area								
Upgradient of UST Area	0	0	0	0	0	1	0	0
UST Area	0	1	0	0	0	0	0	0
Downgradient of UST Area	0	1	0	0	0	1	0	0
OWS Area								
Upgradient of OWS	0	2	0	0	0	0	0	0
OWS Area	0	0	0	0	0	0	0	0
Downgradient of OWS	0	0	0	0	0	3	0	0
Sandbox Area								
Sandbox Area	0	2	0	0	0	0	0	0
Downgradient of Sandbox Area	0	2	0	0	0	1	0	0
2000 Totals	0	8	0	0	0	6	0	0

TABLE 2-6
LARC 60 ANALYTICAL SUMMARY

Sample Type	Sample ID	Analyses						
		VOCs	SVOCs	TPH Light	TPH Heavy	Pest/ PCBs	Total Metals/CN	Dissolved Metals/CN
Groundwater (Monitoring Wells)	6MW-1	S	S	S	S	S	S	S
	6MW-2	S	S	S	S		S	S
	6MW-3S	S	S	S	S	S	S	S
	6MW-3D	S	S	S	S			
	6MW-4	S	S	S	S	S	S	S
	MW-115	S	S	S	S	S	S	S
	MW-117	S	S	S	S	S	S	S
	MW-118	S	S	S	S	S	S	S
Groundwater (DPT Points)	GW06-001	S-GC	S	S-GC	S			
	GW06-002	S-GC	S	S-GC	S			
	GW06-003	S-GC	S	S-GC	S			
	GW06-004	S	S	S	S		S	
	GW06-005	S-GC	S	S-GC	S			
	GW06-006	S-GC	S	S-GC	S			
	GW06-007	S-GC	S	S-GC	S		S	
	GW06-008	S-GC	S	S-GC	S			
	GW06-009	S-GC	S	S-GC	S		S	
	GW06-010	S-GC	S	S-GC	S			
	GW06-011	S	S	S	S			
	GW06-012	S	S	S	S			
	GW06-013	S	S	S	S			
	GW06-014	S	S	S	S			
	GW06-015	S	S	S	S			
	GW06-016	S	S	S	S			
	GW06-017	S	S	S	S			
	GW06-018	S-GC		S-GC				
	GW06-019	GC		GC				
	GW06-020	GC		GC				
	GW06-021	S-GC		S-GC				
	GW06-022	S-GC		S-GC				
	GW06-023	GC		GC				
	GW06-024	GC		GC				
	GW06-025	S						
Groundwater (Well Points)	WP-1	S		S	S			
	WP-2	S		S	S			
	WP-3				S			
Soil Borings (samples collected from 3 depths)	SB06-001	S	S	S	S		S	
	SB06-002	S	S	S	S			
	SB06-004	S	S	S	S			
	SB06-005	S	S	S	S		S	

TABLE 2-6
LARC 60 ANALYTICAL SUMMARY

Sample Type	Sample ID	Analyses						
		VOCs	SVOCs	TPH Light	TPH Heavy	Pest/ PCBs	Total Metals/CN	Dissolved Metals/CN
Soil Boring (sample collected from 1 depth)	SB06-007	S	S	S	S			
Soil Borings (samples collected from 2 depths)	SB06-003	S	S	S	S			
	SB06-006	S	S	S	S			
	SB06-008	S	S	S	S			
	SB06-009	S	S	S	S			
	SB06-010	S	S	S	S		S	
	SB06-011	S	S	S	S			
	SB06-012	S	S	S	S			
	SB06-013	S	S	S	S			
	SB06-014	S	S	S	S			
	SB06-015	S	S	S	S		S	
	SB06-016	S	S	S	S			
	SB06-017	S	S	S	S			
	SB06-018	S	S	S	S			
	SB06-019	S	S	S	S			
	SB06-020	S	S	S	S		S	
	SB06-021	S	S	S	S			
	SB06-022	S	S	S	S			
	SB06-023	S	S	S	S			
Surface Soil	LARC60-SS1					S		
	LARC60-SS2					S		
	LARC60-SS3					S		
	LARC60-SS4					S		
	LARC60-SS5					S		
	LARC60-SS6					S		
	LARC60-SS7					S		
	LARC60-SS8					S		
Surface Water	SW06-001	S	S	S	S		S	
	SW06-002	S	S	S	S		S	
Sediment	SD06-001	S	S	S	S		S	
	SD06-002	S	S	S	S		S	

Notes:

S - Savannah Laboratory analysis only

GC - On site GC analysis only

S-GC - Savannah Laboratory and on-site GC analysis

TABLE 4-9
SOIL RESULTS - LARC 60 SITE

Parameters	SB06-001 0 to 1 ft	SB06-001 5 to 7 ft	SB06-001 10 to 12 ft	SB06-002 0 to 1 ft	SB06-002 4 to 5 ft	SB06-002 8 to 9 ft	SB06-003 0 to 1 ft	SB06-003 5 to 7 ft	EPA Risk Criteria(1)
VOCs (ug/kg)									
Acetone	<26	<26	<27	<25	200	62	<26	<26	20,000,000/780,000
sec-Butyl benzene	NA	NA	NA	NA	NA	NA	< 1.4	NA	8,200,000/310,000
Ethylbenzene	<5.3	<5.2	<5.4	<5.0	<5.2	<5.7	<5.2	<5.2	20,000,000/780,000
Isopropyl benzene	NA	NA	NA	NA	NA	NA	< 1.5	NA	---
p-Isopropyl toluene	NA	NA	NA	NA	NA	NA	< 1.4	NA	---
Methylene Chloride	<5.3	<5.2	<5.4	<5.0	<5.2	<5.7	<5.2	<5.2	760,000/85,000
Methyl ethyl ketone	<26	<26	<27	<25	<26	<28	<26	<26	120,000,000/4,700,000
n-Propyl benzene	NA	NA	NA	NA	NA	NA	< 1.4	NA	820,000/310,000
Styrene	<5.3	<5.2	<5.4	<5.0	<5.2	<5.7	<5.2	<5.2	41,000,000/1,600,000
Tetrachloroethene	<5.3	<5.2	<5.4	<5.0	<5.2	<5.7	<5.2	10	110,000/12,000
Toluene	12	<5.2	<5.4	<5.0	<5.2	<5.7	<5.2	8.2	41,000,000/1,600,000
1,2,3-Trichlorobenzene	NA	NA	NA	NA	NA	NA	< 2.3	NA	---
Trichloroethene	<5.3	<5.2	<5.4	<5.0	<5.2	<5.7	<5.2	<5.2	520,000/58,000
1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA	NA	< 1.4	NA	10,000,000/390,000
1,3,5-Trimethylbenzene	NA	NA	NA	NA	NA	NA	< 1.5	NA	10,000,000/390,000
Xylenes	<5.3	<5.2	<5.4	<5.0	<5.2	<5.7	<5.2	<5.2	41,000,000/1,400,000
SVOCs (ug/kg)									
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	78,000/8,700
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	---
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780/87
Bis(2-EH)phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	51 JB	410,000/46,000
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780,000/87,000
Di-n-butylphthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	59 J	20,000,000/780,000
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8,200,000/310,000
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4,100,000/160,000
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6,100,000/230,000
TPH (mg/kg)									
TPH as Gasoline	<.26	<.26	<.27	<.25	<.26	<.28	<.26	<.26	100 (4)
TPH as Kerosene	<10	<10	<11	<10	<10	<11	<10	NT	100
TPH as Diesel Fuel	<10	<10	<11	<10	<10	<11	<10	NT	100
TPH as Heavy Oils	100	<34	<36	42	<34	<38	<34	NT	100
TPH as Fuel Oil	<34	<34	<36	<33	<34	<38	<34	NT	100
Total Metals (mg/kg)									
Aluminum	2,700 J	280J	250J	NT	NT	NT	NT	NT	100,000/7,800
Arsenic	**1.1**	**1.1**	<1.1	NT	NT	NT	NT	NT	3.8/0.43
Barium	19J	2.3J	2.1J	NT	NT	NT	NT	NT	14,000/550
Cadmium	BDL	BDL	BDL	NT	NT	NT	NT	NT	100/0.39
Calcium	980	<52	<54	NT	NT	NT	NT	NT	-
Chromium	4.3	1.9	3.1	NT	NT	NT	NT	NT	610/23
Cobalt	2.3	<1.0	<1.1	NT	NT	NT	NT	NT	4,100/160
Copper	9.1	<2.6	<2.7	NT	NT	NT	NT	NT	8,200/310
Iron	510	900	870	NT	NT	NT	NT	NT	120,000/4,700
Lead	7.6J	1.3J	1.4J	NT	NT	NT	NT	NT	1,200/400
Magnesium	1400	<52	<54	NT	NT	NT	NT	NT	-
Manganese	120	8.6	6.9	NT	NT	NT	NT	NT	4,100/160
Mercury	BDL	BDL	BDL	NT	NT	NT	NT	NT	-
Nickel	BDL	BDL	BDL	NT	NT	NT	NT	NT	4,100/160
Potassium	1200	<100	<110	NT	NT	NT	NT	NT	-
Silver	BDL	BDL	BDL	NT	NT	NT	NT	NT	1,000/39
Sodium	<53	<52	<54	NT	NT	NT	NT	NT	-
Vanadium	9.2	1.4	<1.3	NT	NT	NT	NT	NT	1,400/55
Zinc	26	3.1	3	NT	NT	NT	NT	NT	61,000/2,300

Notes:
(1) EPA Region III RBCs for Industrial/Residential Soils
(2) BDL - Below detection limit
(3) NT - Not tested
(4) Virginia DEQ Petroleum Program Reporting Level
Shaded/bolded text identifies compounds with concentrations greater than the EPA risk screening criteria

NA - Not analyzed. Parameter detected by USACE NED Lab via use of SW-846 Method 8260.
J - Estimated value
K - Reported value may be biased high
L - Reported value may be biased low

TABLE 4-9
SOIL RESULTS - LARC 60 SITE

Parameters	SB06-004			SB06-005		SB06-006			EPA Risk Criteria(1)
	0 to 1 ft	3 to 5 ft	7 to 9 ft	0 to 1 ft	5 to 7 ft	7 to 9 ft	0 to 1 ft	4 to 5 ft	
VOCs (ug/kg)									
Acetone	<25	<26	<27	<25	<26	<27	<26	<30	20,000,000/780,000
sec-Butyl benzene	NA	NA	< 1.4	NA	NA	NA	NA	NA	8,200,000/310,000
Ethylbenzene	<5.0	<5.2	<5.5	<5.0	<5.2	<5.4	<5.2	<6.0	20,000,000/780,000
Isopropyl benzene	NA	NA	< 1.5	NA	NA	NA	NA	NA	---
p-Isopropyl toluene	NA	NA	< 1.4	NA	NA	NA	NA	NA	---
Methylene Chloride	<5.0	<5.2	7 B	<5.0	<5.2	<5.4	<5.2	17	760,000/85,000
Methyl ethyl ketone	<25	<26	<27	<25	<26	<27	<26	31	120,000,000/4,700,000
n-Propyl benzene	NA	NA	< 1.4	NA	NA	NA	NA	NA	820,000/310,000
Styrene	<5.0	<5.2	<5.5	<5.0	<5.2	<5.4	<5.2	<6.0	41,000,000/1,600,000
Tetrachloroethene	<5.0	<5.2	<5.5	<5.0	<5.2	<5.4	<5.2	<6.0	110,000/12,000
Toluene	<5.0	6.1	<5.5	<5.0	<5.2	<5.4	<5.2	<6.0	41,000,000/1,600,000
1,2,3-Trichlorobenzene	NA	NA	2.7 JB	NA	NA	NA	NA	NA	---
Trichloroethene	<5.0	<5.2	<5.5	<5.0	<5.2	<5.4	<5.2	<6.0	520,000/58,000
1,2,4-Trimethylbenzene	NA	NA	< 1.4	NA	NA	NA	NA	NA	10,000,000/390,000
1,3,5-Trimethylbenzene	NA	NA	< 1.5	NA	NA	NA	NA	NA	10,000,000/390,000
Xylenes	<5.0	<5.2	<5.5	<5.0	<5.2	<5.4	<5.2	<6.0	41,000,000/1,400,000
SVOCs (ug/kg)									
Benzo(a)anthracene	BDL	BDL	27 J	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(b)fluoranthene	BDL	BDL	36 J	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(k)fluoranthene	BDL	BDL	47 J	BDL	BDL	BDL	BDL	BDL	78,000/8,700
Benzo(g,h,i)perylene	BDL	BDL	24 J	BDL	BDL	BDL	BDL	BDL	---
Benzo(a)pyrene	BDL	BDL	35 J	BDL	BDL	BDL	BDL	BDL	780/87
Bis(2-EH)phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	410,000/46,000
Chrysene	BDL	BDL	33 J	BDL	BDL	BDL	BDL	BDL	780,000/87,000
Di-n-butylphthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	20,000,000/780,000
Fluoranthene	BDL	BDL	55 J	BDL	BDL	BDL	BDL	BDL	8,200,000/310,000
Naphthalene	BDL	BDL	4 J	BDL	BDL	BDL	BDL	BDL	4,100,000/160,000
Pyrene	BDL	BDL	50 J	BDL	BDL	BDL	BDL	BDL	6,100,000/230,000
TPH (mg/kg)									
TPH as Gasoline	<.25	<.26	<.27	<.25	<.26	<.27	<.26	<.30	100 (4)
TPH as Kerosene	<20	<10	<11	<10	<21	<11	<10	<12	100
TPH as Diesel Fuel	<20	<10	<11	<10	<21	<11	<10	<12	100
TPH as Heavy Oils	**260**	**240**	**150**	**220**	**270**	**110**	**290**	<39	100
TPH as Fuel Oil	<67	<34	<36	<33	<69	<36	<34	<39	100
Total Metals (mg/kg)									
Aluminum	NT	NT	NT	310J	NT	310K	NT	NT	100,000/7,800
Arsenic	NT	NT	NT	<1.0	NT	<1.1	NT	NT	3.8/0.43
Barium	NT	NT	NT	3.9J	NT	3.5	NT	NT	14,000/550
Cadmium	NT	NT	NT	BDL	NT	BDL	NT	NT	100/0.39
Calcium	NT	NT	NT	160	NT	94	NT	NT	-
Chromium	NT	NT	NT	2.4	NT	2.3	NT	NT	610/23
Cobalt	NT	NT	NT	<1.0	NT	<1.1	NT	NT	4,100/160
Copper	NT	NT	NT	41	NT	3.2	NT	NT	8,200/310
Iron	NT	NT	NT	1000	NT	670L	NT	NT	120,000/4,700
Lead	NT	NT	NT	11J	NT	5.6	NT	NT	1,200/400
Magnesium	NT	NT	NT	94	NT	74	NT	NT	-
Manganese	NT	NT	NT	12	NT	6	NT	NT	4,100/160
Mercury	NT	NT	NT	BDL	NT	BDL	NT	NT	-
Nickel	NT	NT	NT	BDL	NT	BDL	NT	NT	4,100/160
Potassium	NT	NT	NT	<100	NT	<110	NT	NT	-
Silver	NT	NT	NT	BDL	NT	BDL	NT	NT	1,000/39
Sodium	NT	NT	NT	<51	NT	<54	NT	NT	-
Vanadium	NT	NT	NT	1.6	NT	1.6	NT	NT	1,400/55
Zinc	NT	NT	NT	33	NT	8.6	NT	NT	61,000/2,300

Notes:
(1) EPA Region III Risk-based Concentrations for Industrial Soils
(2) BDL - Below detection limit
(3) NT - Not tested
(4) Virginia DEQ Petroleum Program Reporting Level
Shaded/bolded text identifies compounds with concentrations greater than the EPA risk screening criteria

NA - Not analyzed. Parameter detected by USACE NED Lab via use of SW-846 Method 8260.
J - Estimated value
K - Reported value may be biased high
L - Reported value may be biased low

TABLE 4-9
SOIL RESULTS - LARC 60 SITE

Parameters	SB06-007	SB06-008		SB06-009		SB06-010		EPA Risk Criteria(1)
	4 to 5 ft	0 to 1 ft	4 to 5 ft	0 to 1 ft	4 to 5 ft	0 to 1 ft	4 to 5 ft	
VOCs (ug/kg)								
Acetone	<27	<26	<26	36	51	<26	65	20,000,000/780,000
sec-Butyl benzene	2.6 J	NA	NA	NA	NA	NA	NA	8,200,000/310,000
Ethylbenzene	2.3 J	<5.2	<5.2	<5.2	<5.2	<5.2	<5.5	20,000,000/780,000
Isopropyl benzene	1.8 J	NA	NA	NA	NA	NA	NA	---
p-Isopropyl toluene	9.1	NA	NA	NA	NA	NA	NA	---
Methylene Chloride	32	8.9	11	<5.2	<5.2	12	150	760,000/85,000
Methyl ethyl ketone	<27	<26	<26	<26	<26	<26	41	120,000,000/4,700,000
n-Propyl benzene	4.3 J	NA	NA	NA	NA	NA	NA	820,000/310,000
Styrene	1.8 J	<5.2	<5.2	<5.2	<5.2	<5.2	<5.5	41,000,000/1,600,000
Tetrachloroethene	<5.4	<5.2	<5.2	<5.2	<5.2	<5.2	8.8	110,000/12,000
Toluene	<5.4	<5.2	<5.2	<5.2	<5.2	<5.2	6.7	41,000,000/1,600,000
1,2,3-Trichlorobenzene	< 2.6	NA	NA	NA	NA	NA	NA	---
Trichloroethene	<5.4	<5.2	<5.2	<5.2	<5.2	<5.2	8.8	520,000/58,000
1,2,4-Trimethylbenzene	29	NA	NA	NA	NA	NA	NA	10,000,000/390,000
1,3,5-Trimethylbenzene	26	NA	NA	NA	NA	NA	NA	10,000,000/390,000
Xylenes	11	<5.2	<5.2	<5.2	<5.2	<5.2	<5.5	41,000,000/1,400,000
SVOCs (ug/kg)								
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	78,000/8,700
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	---
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780/87
Bis(2-EH)phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	410,000/46,000
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780,000/87,000
Di-n-butylphthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	20,000,000/780,000
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8,200,000/310,000
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4,100,000/160,000
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6,100,000/230,000
TPH (mg/kg)								
TPH as Gasoline	<.27	<.26	<.26	<.26	<.26	<.26	<.27	100 (4)
TPH as Kerosene	<110	<10	<10	<10	<10	<10	<11	100
TPH as Diesel Fuel	<110	<10	<10	<10	<10	<10	<11	100
TPH as Heavy Oils	**880**	<34	<34	<34	<34	**170**	**110**	100
TPH as Fuel Oil	<360	<34	<34	<34	<34	<34	<36	100
Total Metals (mg/kg)								
Aluminum	NT	NT	NT	NT	NT	440	300	100,000/7,800
Arsenic	NT	NT	NT	NT	NT	<1.0	<1.1	3.8/0.43
Barium	NT	NT	NT	NT	NT	3.7	2.9	14,000/550
Cadmium	NT	NT	NT	NT	NT	BDL	BDL	100/0.39
Calcium	NT	NT	NT	NT	NT	110	300	-
Chromium	NT	NT	NT	NT	NT	2.3	1.8	610/23
Cobalt	NT	NT	NT	NT	NT	<1.0	<1.1	4,100/160
Copper	NT	NT	NT	NT	NT	<2.6	<2.7	8,200/310
Iron	NT	NT	NT	NT	NT	1100L	770L	120,000/4,700
Lead	NT	NT	NT	NT	NT	6.4L	4.7L	1,200/400
Magnesium	NT	NT	NT	NT	NT	110	59	-
Manganese	NT	NT	NT	NT	NT	7.2	13	4,100/160
Mercury	NT	NT	NT	NT	NT	BDL	BDL	-
Nickel	NT	NT	NT	NT	NT	BDL	BDL	4,100/160
Potassium	NT	NT	NT	NT	NT	<100	<110	-
Silver	NT	NT	NT	NT	NT	BDL	BDL	1,000/39
Sodium	NT	NT	NT	NT	NT	<52	<55	-
Vanadium	NT	NT	NT	NT	NT	1.9	1.7	1,400/55
Zinc	NT	NT	NT	NT	NT	6.4	5.2	61,000/2,300

Notes:
(1) EPA Region III Risk-based Concentrations for Industrial Soils
(2) BDL - Below detection limit
(3) NT - Not tested
(4) Virginia DEQ Petroleum Program Reporting Level
Shaded/bolded text identifies compounds with concentrations greater than the EPA risk screening criteria

NA - Not analyzed. Parameter detected by USACE NED Lab via use of SW-846 Method 8260.
J - Estimated value
K - Reported value may be biased high
L - Reported value may be biased low

TABLE 4-9
SOIL RESULTS - LARC 60 SITE

Parameters	SB06-011		SB06-012		SB06-013		SB06-014		EPA Risk Criteria(1)
	0 to 1 ft	4 to 5 ft	0 to 1 ft	4 to 5 ft	0 to 1 ft	4 to 5 ft	0 to 1 ft	4 to 5 ft	
VOCs (ug/kg)									
Acetone	<25	<27	<34	<27	<25	<27	<25	<26	20,000,000/780,000
sec-Butyl benzene	NA	NA	NA	NA	NA	NA	NA	NA	8,200,000/310,000
Ethylbenzene	<5.0	<5.5	<6.8	<5.5	<5.0	<5.5	<5.0	<5.2	20,000,000/780,000
Isopropyl benzene	NA	NA	NA	NA	NA	NA	NA	NA	---
p-Isopropyl toluene	NA	NA	NA	NA	NA	NA	NA	NA	---
Methylene Chloride	<5.0	220	<6.8	91	<5.0	19	<5.0	5.4	760,000/85,000
Methyl ethyl ketone	<25	36	<34	44	<25	<27	<25	<26	120,000,000/4,700,000
n-Propyl benzene	NA	NA	NA	NA	NA	NA	NA	NA	820,000/310,000
Styrene	<5.0	9.2	<6.8	7.3	<5.0	<5.5	<5.0	<5.2	41,000,000/1,600,000
Tetrachloroethene	<5.0	<5.5	<6.8	<5.5	<5.0	<5.5	<5.0	<5.2	110,000/12,000
Toluene	<5.0	13	<6.8	11	<5.0	<5.5	<5.0	<5.2	41,000,000/1,600,000
1,2,3-Trichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	---
Trichloroethene	<5.0	16	<6.8	9.3	<5.0	<5.5	<5.0	<5.2	520,000/58,000
1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	10,000,000/390,000
1,3,5-Trimethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	10,000,000/390,000
Xylenes	<5.0	<5.5	<6.8	<5.5	<5.0	<5.5	<5.0	<5.2	41,000,000/1,400,000
SVOCs (ug/kg)									
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	78,000/8,700
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	---
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780/87
Bis(2-EH)phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	410,000/46,000
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780,000/87,000
Di-n-butylphthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	20,000,000/780,000
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8,200,000/310,000
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4,100,000/160,000
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6,100,000/230,000
TPH (mg/kg)									
TPH as Gasoline	<.25	<.27	<.34	<.27	<.25	<.27	<.25	<.26	100 (4)
TPH as Kerosene	<10	<110	<14	<55	<10	<110	<20	<52	100
TPH as Diesel Fuel	<10	<110	<14	<55	<10	<110	<20	<52	100
TPH as Heavy Oils	**170**	**1,200**	**160**	**550**	**290**	**1,400**	**310**	**680**	100
TPH as Fuel Oil	<33	<360	<44	<180	<33	<360	<66	<170	100
Total Metals (mg/kg)									
Aluminum	NT	NT	NT	NT	NT	NT	NT	NT	100,000/7,800
Arsenic	NT	NT	NT	NT	NT	NT	NT	NT	3.8/0.43
Barium	NT	NT	NT	NT	NT	NT	NT	NT	14,000/550
Cadmium	NT	NT	NT	NT	NT	NT	NT	NT	100/0.39
Calcium	NT	NT	NT	NT	NT	NT	NT	NT	-
Chromium	NT	NT	NT	NT	NT	NT	NT	NT	610/23
Cobalt	NT	NT	NT	NT	NT	NT	NT	NT	4,100/160
Copper	NT	NT	NT	NT	NT	NT	NT	NT	8,200/310
Iron	NT	NT	NT	NT	NT	NT	NT	NT	120,000/4,700
Lead	NT	NT	NT	NT	NT	NT	NT	NT	1,200/400
Magnesium	NT	NT	NT	NT	NT	NT	NT	NT	-
Manganese	NT	NT	NT	NT	NT	NT	NT	NT	4,100/160
Mercury	NT	NT	NT	NT	NT	NT	NT	NT	-
Nickel	NT	NT	NT	NT	NT	NT	NT	NT	4,100/160
Potassium	NT	NT	NT	NT	NT	NT	NT	NT	-
Silver	NT	NT	NT	NT	NT	NT	NT	NT	1,000/39
Sodium	NT	NT	NT	NT	NT	NT	NT	NT	-
Vanadium	NT	NT	NT	NT	NT	NT	NT	NT	1,400/55
Zinc	NT	NT	NT	NT	NT	NT	NT	NT	61,000/2,300

Notes:
(1) EPA Region III Risk-based Concentrations for Industrial Soils
(2) BDL - Below detection limit
(3) NT - Not tested
(4) Virginia DEQ Petroleum Program Reporting Level
Shaded/bolded text identifies compounds with concentrations greater than the EPA risk screening criteria

NA - Not analyzed. Parameter detected by USACE NED Lab via use of SW-846 Method 8260.
J - Estimated value
K - Reported value may be biased high
L - Reported value may be biased low

TABLE 4-9
SOIL RESULTS - LARC 60 SITE

Parameters	SB06-015		SB06-016		SB06-017		SB06-018		EPA Risk Criteria(1)
	0 to 1 ft	4 to 5 ft	0 to 1 ft	4 to 5 ft	0 to 1 ft	4 to 5 ft	0 to 1 ft	4 to 5 ft	
VOCs (ug/kg)									
Acetone	<25	<26	<25	<29	<25	<26	<25	<26	20,000,000/780,000
sec-Butyl benzene	NA	NA	NA	NA	NA	NA	NA	NA	8,200,000/310,000
Ethylbenzene	<5.0	<5.2	<5.0	<5.9	<5.0	<5.2	<5.0	<5.2	20,000,000/780,000
Isopropyl benzene	NA	NA	NA	NA	NA	NA	NA	NA	---
p-Isopropyl toluene	NA	NA	NA	NA	NA	NA	NA	NA	---
Methylene Chloride	<5.0	<5.2	<5.0	11	5.5	<5.2	5.2	<5.2	760,000/85,000
Methyl ethyl ketone	<25	<26	<25	<29	<25	<26	<25	<26	120,000,000/4,700,000
n-Propyl benzene	NA	NA	NA	NA	NA	NA	NA	NA	820,000/310,000
Styrene	<5.0	<5.2	<5.0	<5.9	<5.0	<5.2	<5.0	<5.2	41,000,000/1,600,000
Tetrachloroethene	<5.0	<5.2	<5.0	<5.9	<5.0	<5.2	<5.0	<5.2	110,000/12,000
Toluene	<5.0	<5.2	<5.0	<5.9	5.1	<5.2	7.1	<5.2	41,000,000/1,600,000
1,2,3-Trichlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	---
Trichloroethene	<5.0	<5.2	<5.0	<5.9	<5.0	<5.2	<5.0	<5.2	520,000/58,000
1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	10,000,000/390,000
1,3,5-Trimethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	10,000,000/390,000
Xylenes	<5.0	<5.2	<5.0	<5.9	<5.0	<5.2	<5.0	<5.2	41,000,000/1,400,000
SVOCs (ug/kg)									
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	78,000/8,700
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	---
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780/87
Bis(2-EH)phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	410,000/46,000
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780,000/87,000
Di-n-butylphthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	20,000,000/780,000
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8,200,000/310,000
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4,100,000/160,000
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6,100,000/230,000
TPH (mg/kg)									
TPH as Gasoline	<.25	<.26	<.25	<.29	<.25	<.26	<.25	<.26	100 (4)
TPH as Kerosene	<10	<52	<10	<59	<10	<10	<50	<10	100
TPH as Diesel Fuel	<10	<52	<10	<59	<10	<10	<50	<10	100
TPH as Heavy Oils	77	**520**	**190**	**240**	**250**	<34	**800**	<34	100
TPH as Fuel Oil	<33	<170	<33	<190	<33	<34	<10	<34	100
Total Metals (mg/kg)									
Aluminum	250K	360K	NT	NT	NT	NT	NT	NT	100,000/7,800
Arsenic	<1	<1	NT	NT	NT	NT	NT	NT	3.8/0.43
Barium	1.8	5.3	NT	NT	NT	NT	NT	NT	14,000/550
Cadmium	BDL	BDL	NT	NT	NT	NT	NT	NT	100/0.39
Calcium	<51	66	NT	NT	NT	NT	NT	NT	-
Chromium	1.7	3.6	NT	NT	NT	NT	NT	NT	610/23
Cobalt	<1	<1	NT	NT	NT	NT	NT	NT	4,100/160
Copper	2.5	6.9	NT	NT	NT	NT	NT	NT	8,200/310
Iron	400L	780	NT	NT	NT	NT	NT	NT	120,000/4,700
Lead	3.1	17L	NT	NT	NT	NT	NT	NT	1,200/400
Magnesium	<51	79J	NT	NT	NT	NT	NT	NT	-
Manganese	2.4	4.6	NT	NT	NT	NT	NT	NT	4,100/160
Mercury	BDL	BDL	NT	NT	NT	NT	NT	NT	-
Nickel	BDL	BDL	NT	NT	NT	NT	NT	NT	4,100/160
Potassium	<100	<100	NT	NT	NT	NT	NT	NT	-
Silver	BDL	BDL	NT	NT	NT	NT	NT	NT	1,000/39
Sodium	<51	<52	NT	NT	NT	NT	NT	NT	-
Vanadium	1.2	1.5	NT	NT	NT	NT	NT	NT	1,400/55
Zinc	3.8	17	NT	NT	NT	NT	NT	NT	61,000/2,300

Notes:
(1) EPA Region III Risk-based Concentrations for Industrial Soils
(2) BDL - Below detection limit
(3) NT - Not tested
(4) Virginia DEQ Petroleum Program Reporting Level
Shaded/bolded text identifies compounds with concentrations greater than the EPA risk screening criteria

NA - Not analyzed. Parameter detected by USACE NED Lab via use of SW-846 Method 8260.
J - Estimated value
K - Reported value may be biased high
L - Reported value may be biased low

TABLE 4-9
SOIL RESULTS - LARC 60 SITE

Parameters	SB06-019		SB06-020		SB06-021		SB06-022		SB06-023		EPA Risk Criteria(1)
	0-1 ft	4-5 ft	0-1 ft	4-5 ft	0-1 ft	3-4 ft	0-1 ft	4-5 ft	0-1 ft	2-3 ft	
VOCs (ug/kg)											
Acetone	<25	<26	<25	<26	<26	<29	<28	<29	<27	<29	20,000,000/780,000
sec-Butyl benzene	NA	NA	NA	< 1.4	NA	NA	NA	NA	NA	NA	8,200,000/310,000
Ethylbenzene	<5.0	<5.3	<5.0	<5.3	<5.2	<5.8	<5.6	<5.9	<5.4	<5.8	20,000,000/780,000
Isopropyl benzene	NA	NA	NA	< 1.5	NA	NA	NA	NA	NA	NA	---
p-Isopropyl toluene	NA	NA	NA	< 1.4	NA	NA	NA	NA	NA	NA	---
Methylene Chloride	<5.0	<5.3	<5.0	43	34	70	160	<5.9	62	<5.8	760,000/85,000
Methyl ethyl ketone	<25	<26	<25	<26	<26	36	<28	<29	<27	<29	120,000,000/4,700,000
n-Propyl benzene	NA	NA	NA	< 1.4	NA	NA	NA	NA	NA	NA	820,000/310,000
Styrene	<5.0	<5.3	<5.0	<5.3	<5.2	<5.8	<5.6	<5.9	<5.4	<5.8	41,000,000/1,600,000
Tetrachloroethene	<5.0	<5.3	<5.0	71	<5.2	<5.8	<5.6	<5.9	<5.4	<5.8	110,000/12,000
Toluene	<5.0	<5.3	<5.0	<5.3	<5.2	<5.8	<5.6	<5.9	<5.4	<5.8	41,000,000/1,600,000
1,2,3-Trichlorobenzene	NA	NA	NA	< 2.4	NA	NA	NA	NA	NA	NA	---
Trichloroethene	<5.0	<5.3	<5.0	<5.3	<5.2	<5.8	6.4	<5.9	5.9	<5.8	520,000/58,000
1,2,4-Trimethylbenzene	NA	NA	NA	< 1.4	NA	NA	NA	NA	NA	NA	10,000,000/390,000
1,3,5-Trimethylbenzene	NA	NA	NA	< 1.5	NA	NA	NA	NA	NA	NA	10,000,000/390,000
Xylenes	<5.0	<5.3	<5.0	<5.3	<5.2	<5.8	<5.6	<5.9	<5.4	<5.8	41,000,000/1,400,000
SVOCs (ug/kg)											
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(b)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	7,800/870
Benzo(k)fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	78,000/8,700
Benzo(g,h,i)perylene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	---
Benzo(a)pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780/87
Bis(2-EH)phthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	410,000/46,000
Chrysene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	780,000/87,000
Di-n-butylphthalate	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	20,000,000/780,000
Fluoranthene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	8,200,000/310,000
Naphthalene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4,100,000/160,000
Pyrene	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	6,100,000/230,000
TPH (mg/kg)											
TPH as Gasoline	<.25	<.26	<.25	<.26	<.26	<.29	<.28	<.29	<.27	<.29	100 (4)
TPH as Kerosene	<50	<10	<100	<11	<21	<12	<22	<12	<22	<12	100
TPH as Diesel Fuel	<50	<10	<100	<11	<21	<12	<22	<12	<22	<12	100
TPH as Heavy Oils	**660**	<35	**1,500**	<35	**500**	<38	**140**	<39	**250**	<38	100
TPH as Fuel Oil	<170	<35	<330	<35	<69	<98	<74	<39	<71	<38	100
Total Metals (mg/kg)											
Aluminum	NT	NT	370K	380	NT	NT	NT	NT	NT	NT	100,000/7,800
Arsenic	NT	NT	<1	**0.86**	NT	NT	NT	NT	NT	NT	3.8/0.43
Barium	NT	NT	5.9	2.5	NT	NT	NT	NT	NT	NT	14,000/550
Cadmium	NT	NT	BDL	0.18 J	NT	NT	NT	NT	NT	NT	100/0.39
Calcium	NT	NT	56	43	NT	NT	NT	NT	NT	NT	-
Chromium	NT	NT	3.2	1.5	NT	NT	NT	NT	NT	NT	610/23
Cobalt	NT	NT	<1	0.79	NT	NT	NT	NT	NT	NT	4,100/160
Copper	NT	NT	12	5.5	NT	NT	NT	NT	NT	NT	8,200/310
Iron	NT	NT	840L	770	NT	NT	NT	NT	NT	NT	120,000/4,700
Lead	NT	NT	12	3.2L	NT	NT	NT	NT	NT	NT	1,200/400
Magnesium	NT	NT	77	56	NT	NT	NT	NT	NT	NT	-
Manganese	NT	NT	5.6	4.2	NT	NT	NT	NT	NT	NT	4,100/160
Mercury	NT	NT	BDL	4.6	NT	NT	NT	NT	NT	NT	-
Nickel	NT	NT	BDL	0.81	NT	NT	NT	NT	NT	NT	4,100/160
Potassium	NT	NT	<100	37 J	NT	NT	NT	NT	NT	NT	-
Silver	NT	NT	BDL	0.51 J	NT	NT	NT	NT	NT	NT	1,000/39
Sodium	NT	NT	<50	11	NT	NT	NT	NT	NT	NT	-
Vanadium	NT	NT	1.8	1.7	NT	NT	NT	NT	NT	NT	1,400/55
Zinc	NT	NT	12	7.9	NT	NT	NT	NT	NT	NT	61,000/2,300

Notes:
(1) EPA Region III Risk-based Concentrations for Industrial Soils
(2) BDL - Below detection limit
(3) NT - Not tested
(4) Virginia DEQ Petroleum Program Reporting Level
Shaded/bolded text identifies compounds with concentrations greater than the EPA risk screening c

NA - Not analyzed. Parameter detected by USACE NED Lab via use of SW-846 Method 8260.
J - Estimated value
K - Reported value may be biased high
L - Reported value may be biased low

TABLE 4-9

SOIL RESULTS (2000 Sampling) - LARC 60 SITE

Parameters	SS1 0 to 6 in.	SS2 0 to 6 in.	SS3 0 to 6 in.	SS4 0 to 6 in.	SS5 0 to 6 in.	SS6 0 to 6 in.	SS7 0 to 6 in.	SS8 0 to 6 in.	EPA RBC Criteria(1)
PCBs (ug/kg)									
Aroclor-1016	< 34	< 33	< 33	< 34	< 34	< 35	< 33	< 34	82,000/5,500
Aroclor-1221	< 68	< 66	< 67	< 69	< 69	< 71	< 67	< 69	2,900/320
Aroclor-1232	< 34	< 33	< 33	< 34	< 34	< 35	< 33	< 34	2,900/320
Aroclor-1242	< 34	< 33	< 33	< 34	< 34	< 35	< 33	< 34	2,900/320
Aroclor-1248	< 34	< 33	< 33	< 34	< 34	< 35	< 33	< 34	2,900/320
Aroclor-1254	< 34	< 33	< 33	< 34	< 34	< 35	< 33	< 34	2,900/320
Aroclor-1260	< 34	< 33	< 33	< 34	< 34	< 35	< 33	< 34	2,900/320
Pesticides (ug/kg)									
Aldrin	< 1.7	< 1.7	< 1.7	< 1.7	< 1.8	< 9	< 1.7	< 1.7	340/38
alpha-BHC	< 1.7	< 1.7	< 1.7	< 1.7	< 1.8	< 9	< 1.7	< 1.7	910/100
beta-BHC	< 1.7	1.6 JP	< 1.7	< 1.7	< 1.8	< 9	< 1.7	< 1.7	3,200/350
delta-BHC	< 1.7	< 1.7	< 1.7	< 1.7	< 1.8	< 9	< 1.7	< 1.7	-
gamma-BHC (Lindane)	< 1.7	< 1.7	< 1.7	< 1.7	< 1.8	< 9	< 1.7	< 1.7	4,400/490
alpha-Chlordane	< 1.7	< 1.7	0.51 JP	< 1.7	< 1.8	< 9	< 1.7	< 1.7	16,000/1,800
gamma-Chlordane	< 1.7	< 1.7	0.63 J	< 1.7	< 1.8	< 9	0.49 J	< 1.7	16,000/1,800
DDD	< 3.3	< 3.3	1.6 J	1.2 J	< 3.6	4.3 J	2.1 J	< 3.3	24,000/2,700
DDE	< 3.3	< 3.3	0.30 J	< 3.3	1.7 J	13 J	1.0 J	< 3.3	17,000/1,900
DDT	< 3.3	0.55 J	1.8 J	1.3 J	7.1	39	5.2 P	1.6 J	17,000/1,900
Dieldrin	< 3.3	< 3.3	< 3.3	< 3.3	< 3.6	< 18	0.47 JP	< 3.3	360/40
Endosulfan I	< 1.7	< 1.7	< 1.7	< 1.7	< 1.8	< 9	< 1.7	< 1.7	1,200,000/47,000
Endosulfan II	< 3.3	< 3.3	< 3.3	< 3.3	< 3.6	< 18	< 3.3	< 3.3	1,200,000/47,000
Endosulfan sulfate	< 3.3	< 3.3	< 3.3	< 3.3	< 3.6	< 18	< 3.3	< 3.3	-
Endrin	< 3.3	< 3.3	< 3.3	< 3.3	< 3.6	< 18	< 3.3	< 3.3	61,000/2,300
Endrin aldehyde	< 3.3	< 3.3	< 3.3	< 3.3	< 3.6	< 18	< 3.3	< 3.3	-
Endrin ketone	< 3.3	< 3.3	< 3.3	< 3.3	< 3.6	< 18	< 3.3	< 3.3	-
Heptachlor	< 1.7	< 1.7	< 1.7	< 1.7	< 1.8	< 9	< 1.7	< 1.7	1,300/140
Heptachlor epoxide	< 1.7	< 1.7	< 1.7	< 1.7	< 1.8	< 9	< 1.7	< 1.7	630/70
Methoxyclor	< 17	< 17	< 17	< 17	< 18	< 90	< 17	< 17	1,000,000/39,000
Toxaphene	< 170	< 170	< 170	< 170	< 180	< 900	< 170	< 170	5,200/580

Notes:

(1) EPA Region III RBCs for Industrial/Residential Soils (Sept 2001)

Shaded/bolded text identifies compounds with concentrations greater than EPA risk screening criteria

J - Estimated concentration

P - Greater than 25% difference for detected levels in two GC columns

TABLE 4-10
SEDIMENT RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Sample ID and Results		EPA RBC Criteria(1)
	SD06-001	SD06-002	
VOCs (ug/kg)	BDL(2)	BDL	
SVOCs (ug/kg)	BDL	BDL	
TPH (mg/kg)			
TPH as Gasoline	< 0.32	< 0.32	100(3)
TPH-H as Heavy Oils	**2,700**	**530**	100
Total Metals (mg/kg)			
Aluminum	310 J	650 J	100,000 / 7,800
Barium	1.4 J	2.7 J	14,000 / 550
Calcium	53	210	-
Chromium	1.6	2.5	610 / 23
Copper	3.8	9.0	8,200 / 310
Iron	410	940	120,000 / 4,700
Lead	8.2 J	14 J	1,200 / 400
Magnesium	110	250	-
Manganese	3.4	6.9	4,100 / 160
Sodium	< 64	70	-
Vanadium	1.3	2.7	1,400 / 55
Zinc	11	30	61,000 / 2,300

Notes:
(1) EPA Region III Risk-based Concentration Criteria for Industrial/Residential Soils
(2) BDL - Below detection limit
(3) Virginia DEQ Petroleum Program Reporting Level
Shaded/bolded text identifies compounds with concentrations greater than the EPA risk screening criteria
J - Estimated value

TABLE 4-11
SURFACE WATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Sample ID and Results		EPA RBC Criteria(1)
	SW06-001	SW06-002	
VOCs (ug/l)			
Acetone	30	35	61
SVOCs (ug/l)	BDL(2)	BDL	
TPH (mg/l)	BDL	BDL	
Total Metals (ug/l)			
Aluminum	390	420	3,700
Calcium	12,000	11,000	-
Iron	840	1,400	2,200
Lead	7.8	9	15 (3)
Magnesium	15,000	17,000	-
Manganese	**83**	**140**	73
Potassium	9,100	9,400	-
Sodium	120,000	71,000	-
Zinc	40	62	1,100

Notes:
(1) EPA Region III Risk-based Concentration Criteria for Tap Water
(2) BDL - Below detection limit
(3) USEPA action level for drinking water
Shaded/bolded text identifies compounds with concentrations greater than the EPA risk screening criteria

TABLE 4-12
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Well ID and Results								EPA RBC Criteria(1)
	6MW-1	6MW-2	6MW-3S	6MW-3D	6MW-4	MW-115	MW-117	MW-118	
VOCs (ug/l)									
cis 1,2-DCE	<5 / <5	<5	<5 / 2 J	<5	<5 / <5	<5 / <5	**20 / 1,900**	<5 / <5	6.1
Ethylbenzene	<5 / <5	<5	<5 / <5	<5	<5 / <5	<5 / <5	66 / 76	<5 / <5	130
MIBK	<5 / **50**	<5	<5 / **44**	<5	<5 / **19**	<5 / <5	<5 / <250	<5 / <5	14
Tetrachloroethene	<5 / <5	<5	<5 / <5	<5	<5 / <5	<5 / <5	**8.5** / <50	<5 / <5	1.1
Toluene	<5 / <5	<5	<5 / <5	<5	<5 / <5	<5 / <5	**68 / 310**	<5 / <5	75
Trichloroethene	<5 / <5	<5	<5 / 1.3 J	<5	<5 / <5	<5 / <5	**18** / <50	<5 / <5	1.6
Vinyl chloride	<10 / <10	<10	<10 / **3.1 J**	<10	<10 / <10	<10 / <10	<10 / **8.6 J**	<10 / <10	0.015
Xylenes	<5 / <10	<5	<5 / <10	<5	<5 / <10	<5 / <10	290 / 450	<5 / <10	1,200
SVOCs (ug/l)									
2-Methylnaphthalene	<10	<10	**20**	<10	<10	<10	<10	<10	12
Naphthalene	<10	<10	<10	<10	<10	<10	**32**	<10	0.65
Pest/PCBs	BDL	NT (3)	BDL	NT	BDL	BDL	BDL	BDL	
TPH (mg/l)									
TPH as Gasoline	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**3.0**	<0.05	1.0(2)
TPH as Diesel Fuel	<0.30	<0.30	**2.7**	<0.30	<0.30	<0.30	**3.3**	<0.30	1.0(2)
TPH as Heavy Oils	<1.0	<1.0	<5.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0(2)
TPH as Fuel Oil	<1.0	<1.0	<5.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0(2)
TPH as Kerosene	<0.30	<0.30	<1.5	<0.30	<0.30	<0.30	<0.30	<0.30	1.0(2)
Miscellaneous (mg/l)									
TSS	NT / < 5	NT	NT / < 5	NT	NT / < 5	NT / < 5	NT / 6.0	NT / < 5	-
TDS	NT / 74	NT	NT / 130	NT	NT / 280	NT / 110	NT / 65	NT / 160	-

TABLE 4-12
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Well ID and Results								EPA RBC Criteria(1)
	6MW-1	6MW-2	6MW-3S	6MW-3D	6MW-4	MW-115	MW-117	MW-118	
Total Metals (ug/l)									
Aluminum	NT / < 6	590 K	3,700 K / < 6	NT	NT / 260	NT / < 6	1,100 K / 210	3,700 K / < 6	3,700
Antimony	NT / < 2.7	< 50	< 50 / < 2.7	NT	NT / < 2.7	NT / < 2.7	< 50 / < 2.7	< 50 / < 2.7	1.5
Arsenic	NT / < 3	< 10	**14 / < 3**	NT	NT / < 3	NT / < 3	**91 / 21**	< 10 / < 3	0.045
Barium	NT / 5.5 B	14	120 / 22	NT	NT / 17	NT / 16	28 / 19	35 / 5.3 B	260
Beryllium	NT / < 0.10	< 5	< 5 / < 0.10	NT	NT / < 0.10	NT / < 0.10	< 5 / < 0.10	< 5 / < 0.10	7.3
Cadmium	NT / < 0.50	< 5	< 5 / < 0.50	NT	NT / < 0.50	NT / < 0.50	< 5 / < 0.50	< 5 / < 0.50	1.8
Calcium	NT / 6,700	6,400	39,000 / 17,000	NT	NT / 13,000	NT / 18,000	18,000 / 20,000	15,000 / 9,100	-
Chromium	NT / < 0.70	< 10	< 10 / 1.1 B	NT	NT / 2.4 B	NT / < 0.70	< 10 / 2.9 B	< 10 / < 0.70	110
Cobalt	NT / < 0.90	< 10	< 10 / < 0.90	NT	NT / < 0.90	NT / < 0.90	< 10 / < 0.90	< 10 / < 0.90	73
Copper	NT / 1.4 B	< 25	< 25 / 2.1 B	NT	NT / 2.9 B	NT / 14 B	< 25 / 3.4 B	< 25 / 2.4 B	140
Iron	**NT / 4,600**	**12,000**	**16,000 / 2,700**	NT	NT / 1,300	**NT / 6,900**	**14,000 / 17,000**	**3,500** / 270	2,200
Lead	NT / 2.8 B	< 5	8.9 / < 2.4	NT	NT / 2.6 B	NT / 4.7 B	< 5 / 4.1 B	6.7 / < 2.4	15 (4)
Magnesium	NT / 2,700	4,200	5,900 / 2,100	NT	NT / 9,100	NT / 1,500	5,200 / 3,100	6,400 / 2,800	-
Manganese	NT / 44	**100**	**640 / 140**	NT	NT / 76	**NT / 290**	**95 / 110**	25 / 4.2 B	73
Mercury	NT / < 0.10	< 0.20	< 0.20 / < 0.10	NT	NT / < 0.10	NT / < 0.10	< 0.20 / < 0.10	< 0.20 / < 0.10	-
Nickel	NT / < 1.1	< 40	< 40 / < 1.1	NT	NT / < 1.1	NT / < 1.1	< 40 / < 1.1	< 40 / < 1.1	73
Potassium	NT / 2,400	1,800	12,000 / 3,700	NT	NT / 4,400	NT / 5,000	4,300 / 6,400	6,600 / 3,600	-
Selenium	NT / < 3.4	< 10	< 10 / < 3.4	NT	NT / < 3.4	NT / < 3.4	< 10 / < 3.4	< 10 / < 3.4	18
Silver	NT / < 0.50	< 10	< 10 / < 0.50	NT	NT / < 0.50	NT / < 0.50	< 10 / < 0.50	< 10 / < 0.50	18
Sodium	NT / 8,000	25,000	30,000 / 16,000	NT	NT / 69,000	NT / 9,300	8,100 / 8,500	9,300 / 5,300	270,000
Thallium	NT / < 4.3	< 10	< 10 / < 4.3	NT	NT / < 4.3	NT / < 4.3	< 10 / < 4.3	< 10 / < 4.3	0.26
Vanadium	NT / < 0.70	< 10	11 / 1.9 B	NT	NT / 9.5 B	NT / 1.5 B	< 10 / 5.2 B	< 10 / < 0.70	26
Zinc	NT / 3.3 B	33	42 / 4.9 B	NT	NT / 5.4 B	NT / 29	22 / 5.3 B	24 / 3.6 B	1,100

TABLE 4-12
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Well ID and Results								EPA RBC Criteria(1)
	6MW-1	6MW-2	6MW-3S	6MW-3D	6MW-4	MW-115	MW-117	MW-118	
Dissolved Metals (mg/l)									
Aluminum	NT / < 6	< 200	< 200 / 14 BE	NT	NT / 300 E	NT / < 6	< 200 / 79 BE	< 200 / < 6	3,700
Antimony	NT / < 2.7	< 50	**< 50 / 5.4 B**	NT	**NT / 2.8 B**	NT / < 2.7	< 50 / < 2.7	< 50 / < 2.7	1.5
Arsenic	NT / < 3	< 10	< 10 / < 3	NT	NT / < 3	NT / < 3	**40 / 14**	< 10 / < 3	0.045
Barium	NT / 5.3 B	12	70 / 21	NT	NT / 17	NT / 16	21 / 17	40 / 5 B	260
Beryllium	NT / < 0.10	< 5	< 5 / < 0.10	NT	NT / < 0.10	NT / < 0.10	< 5 < 0.10	< 5 / < 0.10	7.3
Cadmium	NT / < 0.50	< 5	< 5 / < 0.50	NT	NT / < 0.50	NT / < 0.50	< 5 / < 0.50	< 5 / < 0.50	1.8
Calcium	NT / 6,300	6,300	36,000 / 16,000	NT	NT / 12,000	NT / 17,000	18,000 / 18,000	17,000 / 8,400	-
Chromium	NT / 0.75 B	< 10	< 10 / 1.1 B	NT	NT / 2.6 B	NT / 1.2 B	< 10 / 2.7 B	< 10 / < 0.70	110
Cobalt	NT / < 0.90	< 10	< 10 / < 0.90	NT	NT / < 0.90	NT / < 0.90	< 10 / < 0.90	< 10 / < 0.90	73
Copper	NT / < 0.90	< 25	< 25 / < 0.90	NT	NT / 30	NT / < 0.90	< 25 / < 0.90	< 25 / < 0.90	140
Iron	**NT / 3,700**	**9,000**	**6,900 / 2,500**	NT	NT / 1,200	**NT / 3,600**	**5,800 / 15,000**	< 50 / 70	2,200
Lead	NT / 3.8 B	< 10	< 10 / 4.7 B	NT	NT / 4.5 B	NT / < 2.4	< 10 / 4.1 B	< 10 / 3.2 B	15 (4)
Magnesium	NT / 2,500	4,000	5,100 / 2,000	NT	NT / 8,700	NT / 1,400	4,900 / 2,800	6,300 / 2,600	-
Manganese	NT / 38	**95**	**530 / 130**	NT	NT / 72	**NT / 270**	**84 / 96**	< 10 / 3.8 B	73
Mercury	NT / < 0.10	< 0.20	< 0.20 / < 0.10	NT	NT / < 0.10	NT / < 0.10	< 0.20 / < 0.10	< 0.20 / < 0.10	-
Nickel	NT / < 1.1	< 40	< 40 / < 1.1	NT	NT / < 1.1	NT / < 1.1	< 40 / < 1.1	< 40 / < 1.1	73
Potassium	NT / 2,400	1,700	11,000 / 3,700	NT	NT / 4,500	NT / 5,000	3,800 / 6,200	6,400 / 3,500	-
Selenium	NT / < 3.4	< 10	< 10 / < 3.4	NT	NT / < 3.4	NT / < 3.4	< 10 / < 3.4	< 10 / < 3.4	18
Silver	NT < 0.50	< 10	< 10 / < 0.50	NT	NT / < 0.50	NT / < 0.50	< 10 / < 0.50	< 10 / < 0.50	18
Sodium	NT / 7,300	24,000	33,000 / 15,000	NT	NT / 66,000	NT / 8,800	10,000 / 7,800	9,800 / 4,800	270,000
Thallium	NT / < 4.3	< 10	< 10 / < 4.3	NT	NT / < 4.3	NT / < 4.3	< 10 / < 4.3	< 10 / < 4.3	0.26
Vanadium	NT / < 0.70	< 10	< 10 / 2.1 B	NT	NT / 9.6 B	NT / 1.1 B	< 10 / 4.3 B	< 10 / < 0.70	26
Zinc	NT / 3.4 B	< 20	< 20 / 4 B	NT	NT / 20 B	NT / 4.5 B	< 20 / 46	26 / 4.3 B	1,100

Notes:

(1) EPA Region III Risk-based Concentration Criteria for Tap Water
(2) Virginia Groundwater Standard for Petroleum Hydrocarbons
(3) NT - Not tested
(4) USEPA Action Level for Lead in Drinking Water

K - Reported value may be biased high
J - Estimated concentration (result between MDL and PQL for organics)
B - Estimated concentration (result between MDL and PQL for inorganics)
E - Reported value is estimated because interference detected

Organics detected are bolded and italicized.
Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

TABLE 4-13
DPT GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Sample ID and Results									EPA RBC Criteria(1)
	GW06-001	GW06-002	GW06-003	GW06-004	GW06-005	GW06-006	GW06-007	GW06-008	GW06-009	
VOCs (ug/l)										
Acetone	<25	<25	<25	<25	<25	<25	<25	<25	30	61
Benzene	<5 / <5(2)	<50 / <25	<5 / <5	<5	<5 / <5	<5 / <10	<5 / <5	<5 / <5	<5 / <10	0.32
cis 1,2-DCE	<5 / <5	**<50 / 150**	**20 / 13**	<5	<5 / <5	<5 / <10	<5 / <5	<5 / <5	<5 / <10	6.1
Ethylbenzene	<5	**530**	<5	<5	<5	<5	<5	<5	<5	130
Tetrachloroethene	<5 / <5	<50 / <25	**170 / 160**	<5	<5 / <5	<5 / <10	<5 / <5	<5 / <5	<5 / <10	1.1
Toluene	<5	**2,200 D**	<5	<5	<5	<5	<5	<5	6.4	75
Trichloroethene	<5 / <5	**<50 / 47**	**260 D / 180**	<5	<5 / <5	<5 / <10	<5 / <5	<5 / <5	<5 / <10	1.6
Vinyl acetate	<10	**220 J**	<10	<10	<10	<10	<10	<10	<10	41
Vinyl chloride	<10 / <5	<100 / <25	<10 / <5	<10	<10 / <10	<10 / 60R	<10 / <5	<10 / 21R	<10 / 85R	0.015
Xylenes	<5	**2,900**	<5	<5	<5	<5	<5	<5	<5	1,200
SVOCs (ug/l)										
m&p-cresol	<10	12	<10	<10	<10	<10	<10	<10	<10	-
2-Methylnaphthalene	<10	**57**	<10	<10	<10	<10	<10	12	<10	12
Naphthalene	<10	**81**	<10	<10	<10	<10	<10	<10	<10	0.65
TPH (mg/l)										
TPH as Gasoline	<0.05 / <0.5	**12 / 8**	<0.05 / <0.5	<0.05	<0.05 / <0.5	<0.05 / <0.5	<0.05 / <0.5	<0.05 / <0.5	0.18 / <0.5	1.0(3)
TPH as Diesel Fuel	<0.30	**21**	<0.30	<0.30	<0.30	<3.0	<0.30	<0.30	<3.0	1.0(3)
TPH as Heavy Oils	<1.0	<20	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<10	1.0(3)
TPH as Fuel Oil	<1.0	<20	<1.0	<1.0	<1.0	<10	<1.0	<1.0	<1.0	1.0(3)
TPH as Kerosene	<0.30	<6.0	<0.30	<0.30	<0.30	<3.0	<0.30	<0.30	<3.0	1.0(3)
Total Metals (ug/l)										
Aluminum	NT(4)	NT	NT	860	NT	NT	**7,300**	NT	**9,900**	3,700
Arsenic	NT	NT	NT	< 10	NT	NT	**20**	NT	**54**	0.045
Barium	NT	NT	NT	14	NT	NT	74	NT	**330**	260
Cadmium	NT	NT	NT	< 5	NT	NT	< 5	NT	**6.8**	1.8
Calcium	NT	NT	NT	6,400	NT	NT	10,000	NT	70,000	-
Chromium	NT	NT	NT	19	NT	NT	**200**	NT	100	110
Cobalt	NT	NT	NT	< 10	NT	NT	< 10	NT	30	73
Copper	NT	NT	NT	< 25	NT	NT	63	NT	**250**	140
Iron	NT	NT	NT	**3,600 L**	NT	NT	**19,000 L**	NT	**52,000**	2,200
Lead	NT	NT	NT	< 5	NT	NT	**54**	NT	**460**	15 (5)
Magnesium	NT	NT	NT	1,300	NT	NT	3,400	NT	19,000	-
Manganese	NT	NT	NT	63	NT	NT	**160**	NT	**1,700**	73
Nickel	NT	NT	NT	< 40	NT	NT	< 40	NT	52	73
Potassium	NT	NT	NT	1,500	NT	NT	3,000	NT	9,800	-
Sodium	NT	NT	NT	4,100	NT	NT	7,300	NT	18,000	-
Vanadium	NT	NT	NT	10	NT	NT	26	NT	**33**	26
Zinc	NT	NT	NT	60	NT	NT	**1,200**	NT	**2,700**	1,100

Notes:

(1) EPA Region III Risk-based Concentration Criteria for Tap Water
(2) <20 / <10 = Savannah Lab result / Earth Tech on-site GC result
(3) BDL - Below detection limit
(4) NT - Not tested
(5) USEPA Action Level for Drinking Water
Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

R - rejected value, on-site GC results for vinyl chloride not confirmed by Savannah Lab GC/MS analysis
D - Concentration from secondary dilution
L - Reported value may be biased low

TABLE 4-13
DPT GROUNDWATER RESULTS - LARC 60 SITE

Parameters	Sample ID and Results								EPA RBC Criteria(1)
	GW06-010	GW06-011	GW06-012	GW06-013	GW06-014	GW06-015	GW06-016	GW06-017	
VOCs (ug/l)									
Benzene	<5 / <5(2)	<5	<5	<5	<5	<5	<5	<5	0.32
Chloroform	<5	**4.6 J**	<5	<5	<5	<5	<5	<5	0.15
cis 1,2-DCE	<5 / <5	3.5 J	<5	<5	<5	<5	<5	<5	6.1
Ethylbenzene	<5	6.6 J	<5	9.3 J	<5	<5	<5	<5	130
p-Isopropyl toluene	NA	2.3 J	NA	NA	NA	NA	NA	NA	--
Methylene chloride	<5	2.7 JB	<5	<5	<5	<5	<5	<5	4.1
MIBK	<25	<25	<25	<25	<25	<25	**54**	<25	14
Tetrachloroethene	<5 / <5	**16**	<5	<5	<5	<5	<5	<5	1.1
Trichloroethene	<5 / <5	**62 J**	<5	<5	<5	<5	<5	<5	1.6
1,2,4-Trimethylbenzene	NA	**5.6**	NA	NA	NA	NA	NA	NA	1.2
1,3,5-Trimethylbenzene	NA	**4.3 J**	NA	NA	NA	NA	NA	NA	1.2
Vinyl chloride	<10 / 200 R	<10	<10	<10	<10	<10	<10	<10	0.015
Xylenes	<5	37 J	<5	<5	<5	<5	<5	<5	1,200
SVOCs (ug/l)									
Acenaphthene	BDL	1 J	BDL	BDL	BDL	BDL	BDL	BDL	37
Bis(2-EH)phthalate	BDL	2 J	BDL	BDL	BDL	BDL	BDL	BDL	4.8
Di-n-butylphthalate	BDL	2 J	BDL	BDL	BDL	BDL	BDL	BDL	370
Fluorene	BDL	1 J	BDL	BDL	BDL	BDL	BDL	BDL	24
2-Methylnaphthalene	BDL	3 J	BDL	BDL	BDL	BDL	BDL	BDL	12
Naphthalene	BDL	**2.8 J**	BDL	BDL	BDL	BDL	BDL	BDL	0.65
Phenanthrene	BDL	2 J	BDL	BDL	BDL	BDL	BDL	BDL	--
TPH (mg/l)									
TPH as Gasoline	<0.05/<0.5	0.40	<0.05	0.25	<0.05	<0.05	<0.05	<0.05	1.0(4)
TPH as Diesel Fuel	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	1.0(4)
TPH as Heavy Oils	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0(4)
TPH as Fuel Oil	<1.0	**2.3**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0(4)
TPH as Kerosene	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	1.0(4)
Total Metals (mg/l)	NT	NT	NT	NT	NT	NT	NT	NT	

Notes:
(1) EPA Region III Risk-based Concentration Criteria for Tap Water
(2) <5 / <5 = Savannah Lab result / Earth Tech on-site GC result
(3) BDL - Below detection limit
(4) Virginia Groundwater Standard for Petroleum Hydrocarbons
(5) NT - Not tested
Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

NA - Not analyzed. Samples not analyzed by 8260 method like USACE NED lab did for QA split sample for GW06-011.

R - rejected value, on-site GC results for vinyl chloride not confirmed by Savannah Lab GC/MS analysis
J - Estimated value

TABLE 4-13
DPT GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Sample ID and Results								EPA RBC Criteria1)
	GW06-018	GW06-019	GW06-020	GW06-021	GW06-022	GW06-023	GW06-024	GW06-025	
VOCs (ug/l)									
Benzene	<5 / <5(2)	NT (3) / <5	NT / <5	<5 / <5	<5 / <5	NT / <5	NT / <5	<5	0.32
Carbon disulfide	10	NT	NT	<5	<5	NT	NT	<5	100
cis 1,2-DCE	<5 / <5	NT / <5	NT / <5	<5 / <5	<5 / <5	NT / <5	NT / <5	<5	6.1
MIBK	<25	<25	<25	<25	<25	<25	<25	**50**	14
Tetrachloroethene	<5 / <5	NT / <5	NT / <5	<5 / <5	<5 / <5	NT / <5	NT / <5	<5	1.1
Trichloroethane	<5 / <5	NT / <5	NT / <5	<5 / <5	<5 / <5	NT / <5	NT / <5	<5	1.6
Vinyl chloride	<10 / 110R	NT / 11R	NT / 24R	<10 / 56R	<10 / 18R	NT / 13R	NT / 24R	<10	0.015
SVOCs (ug/l)	NT	NT	NT	NT	NT	NT	NT	NT	
TPH (mg/l)									
TPH as Gasoline	<0.05 / <0.5	NT / <0.5	NT / <0.5	<0.05 / <0.5	<0.05 / <0.5	NT / <0.5	NT / <0.5	NT	1.0(4)
TPH as Diesel Fuel	NT	NT	NT	NT	NT	NT	NT	NT	1.0(4)
TPH as Heavy Oils	NT	NT	NT	NT	NT	NT	NT	NT	1.0(4)
TPH as Fuel Oil	NT	NT	NT	NT	NT	NT	NT	NT	1.0(4)
TPH as Kerosene	NT	NT	NT	NT	NT	NT	NT	NT	1.0(4)
Total Metals (mg/l)	NT	NT	NT	NT	NT	NT	NT	NT	

Notes:
(1) EPA Region III Risk-based Concentration Criteria for Tap Water
(2) < 5 / <5 = Savannah Lab result / Earch Tech on-site GC result
(3) NT - Not tested
(4) Virginia Groundwater Standard for Petroleum Hydrocarbons
Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

R - rejected value, on-site GC results for vinyl chloride not confirmed by Savannah Lab GC/MS analysis

TABLE 6-14
HAZARD ASSESSMENT FOR SURFACE SOILS - LARC 60 SITE

Parameter	Frequency of Detection	Range of Detection	TBC Criteria			EPA Carcinogen Class (3)	Potential Concern?
			Virginia Petroleum Program (1)	EPA RBC Criteria			
				Industrial Soils (2)	Residential Soils (2)		
VOCs (ug/kg)							
Acetone	1/22	36	-	20,000,000	780,000	D	
Methylene Chloride	7/22	5.2 - 160	-	760,000	85,000	B2	
Toluene	3/22	5.1 - 12	-	41,000,000	1,600,000	D	
Trichloroethene	2/22	5.9 - 6.4	-	520,000	58,000	D	
SVOCs (ug/kg)	0/22	-					
TPH (mg/kg)							
Total TPH	19/22	42 - 1,500	100	-	-	-	
PCBs (ug/kg)							
Aroclors	0/8	-	-	2,900	320	B2	
Pesticides (ug/kg)							
BHC (beta)	1/8	1.6	-	3,200	350	B2	
Chlordane (alpha)	1/8	0.51	-	16,000	1,800	B2	
Chlordane (gamma)	2/8	0.49 - 0.63	-	16,000	1,800	B2	
DDD	4/8	1.2 - 4.3	-	24,000	2,700	B2	
DDE	4/8	0.3 - 13	-	17,000	1,900	B2	
DDT	7/8	0.55 - 39	-	17,000	1,900	B2	
Dieldrin	1/8	0.47	-	360	40	B2	

TABLE 6-14
HAZARD ASSESSMENT FOR SURFACE SOILS - LARC 60 SITE

Parameter	Frequency of Detection	Range of Detection	TBC Criteria			EPA Carcinogen Class (3)	Potential Concern?
			Virginia Petroleum Program (1)	EPA RBC Criteria			
				Industrial Soils (2)	Residential Soils (2)		
Total Metals (mg/kg)							
Aluminum	5/5	250 - 2,700	-	100,000	7,800	-	
Arsenic	1/5	1.1	-	3.8	0.43	A	**Yes**
Barium	5/5	1.8 - 19	-	14,000	550	-	
Calcium	4/5	56 - 980	-	-	-	-	
Chromium	5/5	1.7 - 4.3	-	610	23	-	
Cobalt	1/5	2.3	-	4,100	160	-	
Copper	4/5	2.5 - 41	-	8,200	310	D	
Iron	5/5	400 - 1,100	-	120,000	4,700	-	
Lead	5/5	3.1 - 12	-	1,200	400	B2	
Magnesium	4/5	77 - 1,400	-	-	-	-	
Manganese	5/5	2.4 - 120	-	4,100	160	D	
Potassium	1/5	1,200	-	-	-	-	
Vanadium	5/5	1.2 - 9.2	-	1,400	55	D	
Zinc	5/5	3.8 - 33	-	61,000	2,300	D	

Notes:
(1) Virginia Department of Environmental Quality Petroleum Program Manual (March 1995)
(2) EPA Region III RBC Criteria for Industrial/Residential Soils (Sept 2001)
(3) Weight of Evidence Classification:
A = Human carcinogen
B1 = Probable human carcinogen, limited human data
B2 = Probable human carcinogen, sufficient evidence in animals or no evidence in humans
C = Possible human carcinogen
D = Not classified as to carcinogenicity

TABLE 6-15
HAZARD ASSESSMENT FOR GROUNDWATER
LARC 60 MAINTENANCE AREA

Parameters	Frequency of Detection	Range of Detection	ARARs				TBC Criteria		EPA Carcinogen Class(7)	Potential Concern?
			EPA MCLs(1)	EPA Secondary MCLs(2)	Virginia GW Stds(3)	Va GW Protection Levels(4)	Virginia GW Criteria(5)	EPA RBC Criteria(6) Tap Water		
VOCs (ug/l)										
cis 1,2-DCE	2/6	2 - 1,900	70	-	-	-	-	6.1	D	Yes
Ethylbenzene	1/6	76	700	-	-	-	-	130	D	
MIBK	3/6	19 - 50	-	-	-	-	-	14	D	Yes
Toluene	1/6	310	1,000	-	-	1,000	-	75	D	Yes
TCE	1/6	1.3	5	-	-	5	-	1.6	B2	
Vinyl chloride	2/6	3.1 - 8.6	2	-	-	2	-	0.015	B2	Yes
Xylenes	1/6	450	10,000	-	-	-	-	1,200	D	
SVOCs (ug/l)										
2-Methylnaphthalene	1/8	20	-	-	-	-	-	12	D	Yes
Naphthalene	1/8	32	-	-	-	-	-	0.65	D	Yes
Pesticides/PCBs (ug/l)	0/6	-	-	-	-	-	-	-	-	
Total TPH (mg/l)	2/8	2.7 - 6.3	-	-	1	1	-	-	-	
Dissolved Metals (ug/l)										
Aluminum	3/6	14 - 300	-	50 - 200	-	-	-	3,700	-	
Antimony	2/6	2.8 - 5.4	6	-	-	-	-	1.5	-	Yes
Arsenic	1/6	14	50	-	-	-	-	0.045	B2	Yes
Barium	6/6	5 - 21	1,000	-	1,000	1,000	-	260	-	
Calcium	6/6	6,300 - 18,000	-	-	-	-	-	-	-	
Chromium	5/6	0.75 - 2.7	100	-	50	50	-	11	-	
Copper	1/6	30	1,300	-	1,000	1,000	-	140	D	
Iron	6/6	70 - 15,000	-	300	-	-	300	2,200	-	Yes
Lead	5/6	3.2 - 4.7	15	-	-	-	-	-	-	
Magnesium	6/6	1,400 - 8,700	-	-	-	-	-	-	-	
Manganese	6/6	3.8 - 270	-	50	-	-	50	73	D	Yes
Potassium	6/6	2,400 - 6,200	-	-	-	-	-	-	-	
Sodium	6/6	4,800 - 66,000	-	-	270,000	270,000	100,000	-	-	
Vanadium	4/6	1.1 - 9.6	-	-	-	-	-	26	-	
Zinc	6/6	3.4 - 46	-	5,000	50	50	-	1,100	D	

Notes:
(1) U.S. EPA Maximum Contaminant Levels for Drinking Water (40 CFR 141)
(2) U.S. EPA Secondary Maximum Contaminant Levels for Drinking Water (40 CFR 143)
(3) Virginia Groundwater Quality Standards
(4) Virginia Groundwater Protection Levels from Solid Waste Regulations
(5) Virginia Water Quality Criteria for Groundwater
(6) EPA Region III Risk-based Concentration Table for Tap Water (Sept 2001)

(7) Weight-of-Evidence Classifications
A = Human carcinogen
B1 = Probable human carcinogen, limited human data
B1 = Probable human carcinogen, sufficient data in animals
C = Possible human carcinogen
D = Not classified as to carcinogenicity

TABLE 6-16
HAZARD ASSESSMENT FOR SEDIMENT
LARC 60 MAINTENANCE AREA

Parameter	Frequency of Detection	Range of Detection	TBC Criteria			EPA Carcinogen Class(3)	Potential Concern?
			Virginia Petroleum Program(1)	EPA Region III RBC Criteria			
				Industrial Soils(2)	Residential Soils(2)		
VOCs (ug/kg)	0/2	-					
SVOCs (ug/kg)	0/2	-					
TPH (mg/kg)							
Total TPH	2/2	530 - 2,700	100	-	-	-	
Total Metals (mg/kg)							
Aluminum	2/2	310 - 650	-	100,000	7,800	-	
Barium	2/2	1.4 - 2.7	-	14,000	550	-	
Calcium	2/2	53 - 210	-	-	-	-	
Chromium	2/2	1.6 - 2.5	-	610	23	-	
Copper	2/2	3.8 - 9.0	-	8,200	310	D	
Iron	2/2	310 - 940	-	120,000	4,700	-	
Lead	2/2	8.2 - 14	-	1,200	400	B2	
Magnesium	2/2	110 - 250	-	-	-	-	
Manganese	2/2	3.4 - 6.9	-	4,100	160	D	
Sodium	1/2	70	-	-	-	-	
Vanadium	2/2	1.3 - 2.7	-	1,400	55	D	
Zinc	2/2	11 - 30	-	61,000	2,300	D	

Notes:
(1) Virginia Department of Environmental Quality Petroleum Program Manual (March 1995)
(2) EPA Region III RBC Criteria for Industrial/Residential Soils (Sept 2001)
(3) Weight-of-Evidence Classification:
A = Human carcinogen
B1 = Probable human carcinogen, limited human data
B2 = Probable human carcinogen, sufficient evidence in animals or no evidence in humans
C = Possible human carcinogen
D = Not classified as to carcinogenicity

TABLE 6-17
HAZARD ASSESSMENT FOR SURFACE WATER
LARC 60 MAINTENANCE AREA

Parameters	Frequency of Detection	Range of Detection	ARARs: Virginia SW (Freshwater) Quality Standards[(1)]		ARARs: Federal AWQC (Freshwater)[(2)]		EPA RBC [(3)]	EPA Carcinogen Class [(4)]	Potential Concern?
			Water/Fish	Fish Cons.	Water/Fish	Fish Cons.			
VOCs (ug/l)									
Acetone	2/2	30 - 35	-	-	-	-		D	
SVOCs (ug/l)	0/2	BDL							
Total TPH (mg/l)	0/2	BDL							
Total Metals (ug/l)									
Aluminum	2/2	390 - 420	-	-	-	-	3,700	-	
Calcium	2/2	11,000 - 12,000	-	-	-	-	-	-	
Iron	2/2	840 - 1,400	300	-	-	-	2,200	-	**Yes**
Lead	2/2	7.8 - 9.0	15	-	50	-	-	B2	
Magnesium	2/2	15,000 - 17,000	-	-	-	-	-	-	
Manganese	2/2	83 - 140	50	-	-	-	73	D	**Yes**
Potassium	2/2	9,100 - 9,400	-	-	-	-	-	-	
Sodium	1/2	120,000	-	-	-	-	-	-	
Zinc	2/2	40 - 62	5,000	-	-	-	1,100	D	

Notes:
(1) Virginia Surface Water Quality Standards
(2) Federal Ambient Water Quality Criteria (40 CFR 131)
(3) Weight of Evidence Classification:
A = Human carcinogen
B1 = Probable human carcinogen, limited human data
B2 = Probable human carcinogen
C = Possible human carcinogen
D = Not classified as to carcinogenicity

(4) EPA Region III Risk-based Concentration Table for Tap Water (Oct 2000)
Non-carcinogenic RBCs have been adjusted to a hazard quotient of 0.1

TABLE 6-18
HAZARD ASSESSMENT FOR SURFACE AND SUBSURFACE SOILS - LARC 60 SITE

Parameter	Frequency of Detection	Range of Detection	TBC Criteria: Virginia Petroleum Program (1)	TBC Criteria: EPA RBC Criteria: Industrial Soils (2)	TBC Criteria: EPA RBC Criteria: Residential Soils (2)	EPA Carcinogen Class (3)	Potential Concern?
VOCs (ug/kg)							
Acetone	5/49	36 - 200	-	20,000,000	780,000	D	
sec-Butyl benzene	1/4	2.6	-	8,200,000	310,000	D	
Ethylbenzene	1/49	2.3	-	20,000,000	780,000	D	
Isopropyl benzene	1/4	1.8	-	-	-	D	
p-Isopropyl toluene	1/4	9.1	-	-	-	D	
Methylene Chloride	19/49	5.2 - 220	-	760,000	85,000	B2	
Methyl ethyl ketone	5/49	31 - 44	-	120,000,000	4,700,000	D	
n-Propyl benzene	1/4	4.3	-	820,000	310,000	D	
Styrene	3/49	1.8 - 9.2	-	41,000,000	1,600,000	D	
Tetrachloroethene	3/49	8.8 - 71	-	110,000	12,000	B2	
Toluene	8/49	5.1 - 13	-	41,000,000	1,600,000	D	
1,2,3-Trichloroethane	1/4	2.7	-	-	-	D	
Trichloroethene	5/49	5.9 - 16	-	520,000	58,000	D	
1,2,4-Trimethylbenzene	1/4	29	-	10,000,000	390,000	D	
1,3,5-Trimethylbenzene	1/4	26	-	10,000,000	390,000	D	
Xylenes	1/49	11	-	41,000,000	1,600,000	D	
SVOCs (ug/kg)							
Benzo(a)anthracene	1/49	27	-	7,800	870	B2	
Benzo(b)fluoranthene	1/49	36	-	7,800	870	B2	
Benzo(k)fluoranthene	1/49	47	-	78,000	8,700	B2	
Benzo(g,h,I)perylene	1/49	24	-	-	-	D	
Benzo(a)pyrene	1/49	35	-	780	87	B2	
Bis(2-EH)phthalate	1/49	51	-	410,000	46,000	B2	
Chrysene	1/49	33	-	780,000	87,000	B2	
Di-n-butylphthalate	1/49	59	-	20,000,000	780,000	D	
Fluoranthene	1/49	55	-	8,200,000	310,000	D	
Naphthalene	1/49	4	-	4,100,000	160,000	D	
Pyrene	1/49	50	-	6,100,000	230,000	D	
TPH (mg/kg)	19/22	42 - 1,500	100	-	-	-	
PCBs (ug/kg)	0/8	-	-	2,900	320	B2	

TABLE 6-18
HAZARD ASSESSMENT FOR SURFACE AND SUBSURFACE SOILS - LARC 60 SITE

Parameter	Frequency of Detection	Range of Detection	TBC Criteria			EPA Carcinogen Class (3)	Potential Concern?
			Virginia Petroleum Program (1)	EPA RBC Criteria			
				Industrial Soils (2)	Residential Soils (2)		
Pesticides (ug/kg)							
BHC (beta)	1/8	1.6	-	3,200	350	B2	
Chlordane (alpha)	1/8	0.51	-	16,000	1,800	B2	
Chlordane (gamma)	2/8	0.49 - 0.63	-	16,000	1,800	B2	
DDD	4/8	1.2 - 4.3	-	24,000	2,700	B2	
DDE	4/8	0.3 - 13	-	17,000	1,900	B2	
DDT	7/8	0.55 - 39	-	17,000	1,900	B2	
Dieldrin	1/8	0.47	-	360	40	B2	
Total Metals (mg/kg)							
Aluminum	11/11	250 - 2,700	-	100,000	7,800	-	
Arsenic	3/11	0.86 - 1.1	-	3.8	0.43	A	Yes
Barium	11/11	1.8 - 19	-	14,000	550	-	
Cadmium	1/11	0.18	-	100	0.39	D	
Calcium	11/11	43 - 980	-	-	-	-	
Chromium	11/11	1.5 - 4.3	-	610	23	-	
Cobalt	2/11	0.79 - 2.3	-	4,100	160	-	
Copper	7/11	2.5 - 41	-	8,200	310	D	
Iron	11/11	400 - 1,100	-	120,000	4,700	-	
Lead	11/11	1.3 - 17	-	1,200	400	B2	
Magnesium	8/11	56 - 1,400	-	-	-	-	
Manganese	11/11	2.4 - 120	-	4,100	160	D	
Mercury	1/11	4.6	-	-	-	D	
Nickel	1/11	0.81	-	4,100	160	D	
Potassium	2/11	37 - 1,200	-	-	-	-	
Silver	1/11	0.51	-	1,000	39	D	
Vanadium	10/11	1.2 - 9.2	-	1,400	55	D	
Zinc	11/11	3 - 33	-	61,000	2,300	D	

Notes:
(1) Virginia Department of Environmental Quality Petroleum Program Manual (March 1995)
(2) EPA Region III RBC Criteria for Industrial/Residential Soils (Sept 2001)
(3) Weight of Evidence Classification:
A = Human carcinogen
B1 = Probable human carcinogen, limited human data
B2 = Probable human carcinogen, sufficient evidence in animals or no evidence in humans
C = Possible human carcinogen
D = Not classified as to carcinogenicity

TABLE 6-19
COMPARISON OF EXPOSURE CONCENTRATIONS
LARC 60 Maintenance Area

POPULATIONS AND PATHWAYS	MAXIMUM CONCENTRATION	95th PERCENTILE UCL
ON-SITE RESIDENTIAL POPULATION - FUTURE LAND USE		
Soils		
Ingestion of and Dermal Contact with Chemicals	mg/kg	mg/kg
Arsenic	1.1	**0.86**
Groundwater		
Ingestion of, Dermal Contact with, and Inhalation of Chemicals	ug/l	ug/l
Cis 1,2-DCE	1,900	**1,900**
MIBK	**50**	125
Toluene	310	**310**
Vinyl chloride	8.6	**7.4**
2-Methylnaphthalene	20	**20**
Naphthalene	32	**32**
Antimony	5.4	**5.4**
Arsenic	14	**14**
Iron	15,000	**15,000**
Manganese	270	**191**

Notes:
Bolded/shaded numbers indicate the concentrations to be used in the quantitative assessment
NA - Not applicable because insufficient number of samples to calculate 95th percentile UCL.

TABLE 6-21
TOXICITY VALUES: NON-CARCINOGENIC EFFECTS
ORAL ROUTE
LARC 60 MAINTENANCE AREA

COPC	Chronic RfDo (mg/kg-day)	Adjusted RfD [1] (mg/kg-day)	Confidence Level	Critical Effect	RfD Basis/ Source	Uncertainty Factor	Modifying Factors
METALS							
Antimony	4.00E-04	8.00E-06	Low	Lung irritation, CVS	Oral/IRIS	1000	1
Arsenic	3.00E-04	1.23E-04	Low	Perpigmentation, keratosis	Oral/IRIS	3	1
Iron	3.00E-01	4.50E-02	Medium	Hemosiderosis	Oral	10	1
Manganese	2.30E-02	9.20E-04	Medium	CNS effects	IRIS	1	1
VOCs							
cis 1,2-DCE	1.00E-02	1.00E-02	Pending	Decreased hematocrit	Oral/EPA	3000	1
MIBK	8.00E-02	6.40E-02	Medium	Lethargy	Oral/EPA	3000	1
Toluene	2.00E-01	1.60E-01	Medium	Changes in weight	Oral/NTP	1000	1
Vinyl chloride (child)	3.00E-03	3.00E-03	Low	Increased liver weights, hematological changes	Oral/IRIS	1000	1
Vinyl chloride (adult)	3.00E-03	3.00E-03	Low	Increased liver weights, hematological changes	Oral/IRIS	1000	1
SVOCs							
2-Methylnaphthalene	2.00E-02	1.60E-02	Medium	Increased relative liver weight	Oral	1000	1
Naphthalene	2.00E-02	1.60E-02	Medium	Increased relative liver weight	Oral	1000	1

Notes:

(1) RfD adjusted for dermal exposures by using absorption efficiency factors
(Adjusted RfD = RfDo x absorption efficiency factor)

TABLE 6-22
TOXICITY VALUES: CARCINOGENIC EFFECTS FOR ORAL ROUTES
LARC 60 MAINTENANCE AREA

COPC	CPSo (mg/kg-day)$^{-1}$	Adjusted CPS(1) (mg/kg-day)$^{-1}$	Weight of Evidence Class	Type of Cancer	SF Basis	SF Source
METALS						
Antimony	---	---	D			
Arsenic	1.50E+00	3.66E+00	A	Skin and lung	Oral	IRIS
Iron	---	---	D			
Manganese	---	---	D			
VOCs						
cis 1,2-DCE	---	---	D			
MIBK	---	---	D			
Toluene	---	---	D			
Vinyl chloride (child)	1.40E+00	1.40E+00	A	Liver, kidney, lung, and brain tumors	Oral	IRIS
Vinyl chloride (adult)	7.20E-01	7.20E-01	A	Liver, kidney, lung, and brain tumors	Oral	IRIS
SVOCs						
2-Methylnaphthalene	---	---	D			
Naphthalene	---	---	D			

Notes:

(1) CPS adjusted for dermal exposures by using absorption efficiency factors
(Adjusted CPS = CPSo/absorption efficiencey factor)

(2) IRIS - Integrated Risk Information System (USEPA database)

(3) HEAST - Health Effects Assessment Summary Table

TABLE 6-23
CHRONIC HAZARD INDEX ESTIMATES (NONCANCER EFFECTS)
RESIDENTIAL POPULATION

Exposure Pathway	COPC	CDI (mg/kg-day)	RfD Adjusted For Absorption	RfD (mg/kg-day)	Hazard Quotient	Pathway Hazard Index
ADULTS						
Ingestion of COPC in Soil	Arsenic	1.18E-06	No	3.00E-04	3.93E-03	3.93E-03
Dermal Contact with COPC in Soil	Arsenic	2.71E-07	Yes	1.23E-04	2.20E-03	2.20E-03
Ingestion of COPCs in Groundwater	cis 1,2-DCE	5.21E-02	No	1.00E-02	5.21E+00	
	MIBK	1.37E-03	No	8.00E-02	1.71E-02	
	Toluene	8.49E-03	No	2.00E-01	4.25E-02	
	Vinyl chloride	2.03E-04	No	3.00E-03	6.77E-02	
	2-Methylnaphthalene	5.48E-04	No	2.00E-02	2.74E-02	
	Naphthalene	8.77E-04	No	2.00E-02	4.39E-02	
	Antimony	1.48E-04	No	4.00E-04	3.70E-01	
	Arsenic	3.84E-04	No	3.00E-04	1.28E+00	
	Iron	4.11E-01	No	3.00E-01	1.37E+00	
	Manganese	5.23E-03	No	2.30E-02	2.27E-01	8.66E+00
Dermal Contact with COPCs in Groundwater	cis 1,2-DCE	1.51E-03	Yes	1.00E-02	1.51E-01	
	MIBK	1.32E-05	Yes	6.40E-02	2.06E-04	
	Toluene	1.11E-03	Yes	1.60E-01	6.94E-03	
	Vinyl chloride	4.31E-06	Yes	3.00E-03	1.44E-03	
	2-Methylnaphthalene	2.39E-04	Yes	1.60E-02	1.49E-02	
	Naphthalene	1.76E-04	Yes	1.60E-02	1.10E-02	
	Antimony	4.31E-07	Yes	8.00E-06	5.39E-02	
	Arsenic	1.12E-06	Yes	1.23E-04	9.11E-03	
	Iron	1.20E-03	Yes	4.50E-02	2.67E-02	
	Manganese	1.52E-05	Yes	9.20E-04	1.65E-02	2.92E-01
Inhalation of COPCs in Groundwater	cis 1,2-DCE	3.73E-01	No	---	---	
	MIBK	1.01E-02	No	2.00E-02	5.05E-01	
	Toluene	6.32E-02	No	1.14E-01	5.54E-01	
	Vinyl chloride	1.76E-03	No	2.80E-02	6.29E-02	
	2-Methylnaphthalene	2.59E-03	No	---	---	
	Naphthalene	4.23E-03	No	9.00E-04	4.70E+00	
	Antimony	0.00E+00	No	---	---	
	Arsenic	0.00E+00	No	---	---	
	Iron	0.00E+00	No	---	---	
	Manganese	0.00E+00	No	---	---	5.82E+00
				Total Exposure Hazard Index		**1.48E+01**

TABLE 6-23
CHRONIC HAZARD INDEX ESTIMATES (NONCANCER EFFECTS)
RESIDENTIAL POPULATION

Exposure Pathway	COPC	CDI (mg/kg-day)	RfD Adjusted For Absorption	RfD (mg/kg-day)	Hazard Quotient	Pathway Hazard Index
CHILDREN						
Ingestion of COPC in Soil	Arsenic	1.10E-05	No	3.00E-04	3.67E-02	3.67E-02
Dermal Contact with COPC in Soil	Arsenic	7.30E-07	Yes	1.23E-04	5.93E-03	5.93E-03
Ingestion of COPCs in Groundwater	cis 1,2-DCE	1.21E-01	No	1.00E-02	1.21E+01	
	MIBK	3.20E-03	No	8.00E-02	4.00E-02	
	Toluene	1.98E-02	No	2.00E-01	9.90E-02	
	Vinyl chloride	4.73E-04	No	3.00E-03	1.58E-01	
	2-Methylnaphthalene	1.28E-03	No	2.00E-02	6.40E-02	
	Naphthalene	2.05E-03	No	2.00E-02	1.03E-01	
	Antimony	3.45E-04	No	4.00E-04	8.63E-01	
	Arsenic	8.95E-04	No	3.00E-04	2.98E+00	
	Iron	9.59E-01	No	3.00E-01	3.20E+00	
	Manganese	1.22E-02	No	2.30E-02	5.30E-01	2.01E+01
Dermal Contact with COPCs in Groundwater	cis 1,2-DCE	2.66E-03	Yes	1.00E-02	2.66E-01	
	MIBK	2.31E-05	Yes	6.40E-02	3.61E-04	
	Toluene	1.96E-03	Yes	1.60E-01	1.23E-02	
	Vinyl chloride	7.57E-06	Yes	3.00E-03	2.52E-03	
	2-Methylnaphthalene	4.21E-04	Yes	1.60E-02	2.63E-02	
	Naphthalene	3.10E-04	Yes	1.60E-02	1.94E-02	
	Antimony	7.57E-07	Yes	8.00E-06	9.46E-02	
	Arsenic	1.96E-06	Yes	1.23E-04	1.59E-02	
	Iron	2.10E-03	Yes	4.50E-02	4.67E-02	
	Manganese	2.68E-05	Yes	9.20E-04	2.91E-02	5.13E-01
Inhalation of COPCs in Groundwater	cis 1,2-DCE	1.05E+00	No	---	---	
	MIBK	2.83E-02	No	2.00E-02	1.42E+00	
	Toluene	1.78E-01	No	1.14E-01	1.56E+00	
	Vinyl chloride	4.95E-03	No	2.80E-02	1.77E-01	
	2-Methylnaphthalene	7.29E-03	No	---	---	
	Naphthalene	1.19E-02	No	9.00E-04	1.32E+01	
	Antimony	0.00E+00	No	---	---	
	Arsenic	0.00E+00	No	---	---	
	Iron	0.00E+00	No	---	---	
	Manganese	0.00E+00	No	---	---	1.64E+01
				Total Exposure Hazard Index		**3.71E+01**

Notes:
CDI = Chronic Daily Intake
RfD = Reference dose
Hazard Quotient = CDI/RfD

TABLE 6-24
CANCER RISK ESTIMATES
RESIDENTIAL POPULATION

Exposure Pathway	COPC	CDI (mg/kg-day)	CPS Adjusted For Absorption	CPS $(mg/kg\text{-}day)^{-1}$	Chemical Risk	Total Pathway Risk
ADULTS						
Ingestion of COPC in Soil	Arsenic	4.04E-07	No	1.50E+00	6.06E-07	6.06E-07
Dermal Contact with COPC in Soil	Arsenic	9.31E-08	Yes	3.66E+00	3.41E-07	3.41E-07
Ingestion of COPCs in Groundwater	cis 1,2-DCE	1.78E-02	No	---	0.00E+00	
	MIBK	4.70E-04	No	---	0.00E+00	
	Toluene	2.91E-03	No	---	0.00E+00	
	Vinyl chloride	6.95E-05	No	7.20E-01	5.00E-05	
	2-Methylnaphthalene	1.88E-04	No	---	0.00E+00	
	Naphthalene	3.01E-04	No	---	0.00E+00	
	Antimony	5.07E-05	No	---	0.00E+00	
	Arsenic	1.32E-04	No	1.50E+00	1.98E-04	
	Iron	1.41E-01	No	---	0.00E+00	
	Manganese	1.79E-03	No	---	0.00E+00	2.48E-04
Dermal Contact with COPCs in Groundwater	cis 1,2-DCE	5.19E-04	Yes	---	0.00E+00	
	MIBK	4.51E-06	Yes	---	0.00E+00	
	Toluene	3.81E-04	Yes	---	0.00E+00	
	Vinyl chloride	1.48E-06	Yes	7.20E-01	1.06E-06	
	2-Methylnaphthalene	8.20E-05	Yes	---	0.00E+00	
	Naphthalene	6.04E-05	Yes	---	0.00E+00	
	Antimony	1.48E-07	Yes	---	0.00E+00	
	Arsenic	3.83E-07	Yes	3.66E+00	1.40E-06	
	Iron	4.10E-04	Yes	---	0.00E+00	
	Manganese	5.22E-06	Yes	---	0.00E+00	2.46E-06
Inhalation of COPCs in Groundwater	cis 1,2-DCE	1.28E-01	No	---	0.00E+00	
	MIBK	3.45E-03	No	---	0.00E+00	
	Toluene	2.17E-02	No	---	0.00E+00	
	Vinyl chloride	6.04E-04	No	3.00E-02	1.81E-05	
	2-Methylnaphthalene	8.89E-04	No	---	0.00E+00	
	Naphthalene	1.45E-03	No	---	0.00E+00	
	Antimony	0.00E+00	No	---	0.00E+00	
	Arsenic	0.00E+00	No	---	0.00E+00	
	Iron	0.00E+00	No	---	0.00E+00	
	Manganese	0.00E+00	No	---	0.00E+00	1.81E-05
					Total Exposure Hazard Index	**2.70E-04**

TABLE 6-24
CANCER RISK ESTIMATES
RESIDENTIAL POPULATION

Exposure Pathway	COPC	CDI (mg/kg-day)	CPS Adjusted For Absorption	CPS $(mg/kg\text{-}day)^{-1}$	Chemical Risk	Total Pathway Risk
CHILDREN						
Ingestion of COPC in Soil	Arsenic	9.42E-07	No	1.50E+00	1.41E-06	1.41E-06
Dermal Contact with COPC in Soil	Arsenic	6.52E-08	Yes	3.66E+00	2.39E-07	2.39E-07
Ingestion of COPCs in Groundwater	cis 1,2-DCE	1.04E-02	No	---	0.00E+00	
	MIBK	2.74E-04	No	---	0.00E+00	
	Toluene	1.70E-03	No	---	0.00E+00	
	Vinyl chloride	4.05E-05	No	1.40E+00	5.68E-05	
	2-Methylnaphthalene	1.10E-04	No	---	0.00E+00	
	Naphthalene	1.75E-04	No	---	0.00E+00	
	Antimony	2.96E-05	No	---	0.00E+00	
	Arsenic	7.67E-05	No	1.50E+00	1.15E-04	
	Iron	8.22E-02	No	---	0.00E+00	
	Manganese	1.05E-03	No	---	0.00E+00	1.72E-04
Dermal Contact with COPCs in Groundwater	cis 1,2-DCE	2.28E-04	Yes	---	0.00E+00	
	MIBK	1.98E-06	Yes	---	0.00E+00	
	Toluene	1.68E-04	Yes	---	0.00E+00	
	Vinyl chloride	6.49E-07	Yes	1.40E+00	9.09E-07	
	2-Methylnaphthalene	3.60E-05	Yes	---	0.00E+00	
	Naphthalene	2.65E-05	Yes	---	0.00E+00	
	Antimony	6.49E-08	Yes	---	0.00E+00	
	Arsenic	1.68E-07	Yes	3.66E+00	6.16E-07	
	Iron	1.80E-04	Yes	---	0.00E+00	
	Manganese	2.30E-06	Yes	---	0.00E+00	1.52E-06
Inhalation of COPCs in Groundwater	cis 1,2-DCE	8.99E-02	No	---	0.00E+00	
	MIBK	2.42E-03	No	---	0.00E+00	
	Toluene	1.52E-02	No	---	0.00E+00	
	Vinyl chloride	4.25E-04	No	1.50E-02	6.37E-06	
	2-Methylnaphthalene	6.25E-04	No	---	0.00E+00	
	Naphthalene	1.02E-03	No	---	0.00E+00	
	Antimony	0.00E+00	No	---	0.00E+00	
	Arsenic	0.00E+00	No	---	0.00E+00	
	Iron	0.00E+00	No	---	0.00E+00	
	Manganese	0.00E+00	No	---	0.00E+00	6.37E-06
				Total Exposure Hazard Index		**1.81E-04**

Notes:
CDI = Chronic Daily Intake
CPS - Cancer Potency Slope
Risk = CDI x CPS

FEASIBILITY STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

Total Pathway **Based on contaminated Water** **Residential Scenario** NonRad Equation Rad Equation	**Equation Parameters** Adult Surface Area= 0.731 (m^2/day) Average Lifetime= 70 (year) Body Weight= 15 (kg) Exposure Duration= 6 (year) Exposure Frequency= 350 (day/year) Exposure Time= 0.2 (hr/day) Ingestion Rate = 1 (L/day) Inhalation Rate= 12 (m^3/day)

Preliminary Remediation Goals

Analyte	CAS Number	Carcinogenic 1E-4	Carcinogenic 1E-6	Noncarcinogenic HQ=1	Noncarcinogenic HQ=0.1
Organics -- Units = mg/L					
Naphthalene	91203	No Slope Factor		2.2E-03	2.2E-04

Dermal Pathway **Based on contaminated Water** **Residential Scenario** NonRad Equation	**Equation Parameters** Adult Surface Area= 0.731 (m^2/day) Average Lifetime= 70 (year) Body Weight= 15 (kg) Exposure Duration= 6 (year) Exposure Frequency= 350 (day/year) Exposure Time= 0.2 (hr/day)

Preliminary Remediation Goals

Analyte	CAS Number	Carcinogenic 1E-4	Carcinogenic 1E-6	Noncarcinogenic HQ=1	Noncarcinogenic HQ=0.1
Organics -- Units = mg/L					
Naphthalene	91203	No Slope Factor		2.5E+00 [†]	2.5E-01 [†]

Ingestion Pathway **Based on contaminated Water** **Residential Scenario** NonRad Equation Rad Equation	**Equation Parameters** Average Lifetime= 70 (year) Body Weight= 15 (kg) Exposure Duration= 6 (year) Exposure Frequency= 350 (day/year) Ingestion Rate = 1 (L/day)

Preliminary Remediation Goals

Analyte	CAS Number	Carcinogenic 1E-4	Carcinogenic 1E-6	Noncarcinogenic HQ=1	Noncarcinogenic HQ=0.1
Organics -- Units = mg/L					
Naphthalene	91203	No Slope Factor		3.1E-01	3.1E-02

Inhalation Pathway **Based on contaminated Water** **Residential Scenario** NonRad Equation [1] Rad Equation	**Equation Parameters** Average Lifetime= 70 (year) Body Weight= 15 (kg) Exposure Duration= 6 (year) Exposure Frequency= 350 (day/year) Inhalation Rate= 12 (m^3/day)

Preliminary Remediation Goals

Analyte	CAS Number	Carcinogenic 1E-4	Carcinogenic 1E-6	Noncarcinogenic HQ=1	Noncarcinogenic HQ=0.1
Organics -- Units = mg/L					
Naphthalene	91203	No Unit Risk		2.2E-03 [††]	2.2E-04 [††]

FEASIBILITY STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

Preliminary Costs for Comparison Purposes
LARC 60 Maintenance Area Feasibility Study
Fort Story, VA

Alternative 2 In situ Chemical Oxidation					
Description	Unit	Quantity	Labor Material & Equipment Cost	Subtotal	Total
Remediation System Construction					
Well installation (30-ft hollow-stem auger, includes asphalt cutting)	each	30	$2,200	$66,000	
Soil cuttings and purge groundwater disposal	lump sum	1	$8,000	$8,000	
Subtotal of Construction					**$74,000**
Remedial Action					
Pilot Testing	lump sum	1	$50,000	$50,000	
Chemical oxidation (product, delivery)	pound	50000	$1.25	$62,500	
Injection event (labour, materials, mobilization)	day	14	$9,500	$133,000	
Subtotal of Remedial Action					**$245,500**
Mobilization (5%)	percent of total	0.05	$319,500	$15,975	$15,975
Adminstration (5%)	percent of total	0.05	$319,500	$15,975	$15,975
Engineering (10%)	percent of total	0.1	$319,500	$31,950	$31,950
Contingency (20%)	percent of total	0.2	$319,500	$63,900	$63,900
Total Capital Costs					**$447,300**
Operation&Mantenance (Annualized)					
Chemical oxidation (product, delivery)	pound	20000	$1.25	$25,000	
Maintenance injections	day	7	$9,500	$66,500	
Subtotal of O&M					**$91,500**
Adminstration (5%)	percent of total	0.05	$91,500	$4,575	$4,575
Total Annual O&M					**$96,075**
O&M Present Worth (for 2 years)					**$183,837**
Total Present Worth for Comparison					**$631,137**

Preliminary Costs for Comparison Purposes
LARC 60 Maintenance Area Feasibility Study
Fort Story, VA

Alternative 3 In situ Bioremediation					
Description	Unit	Quantity	Labor Material & Equipment Cost	Subtotal	Total
Remediation System Construction					
Well installation (30-ft hollow-stem auger, includes asphalt cutting)	each	30	$2,200	$66,000	
Soil cuttings and purge groundwater disposal	lump sum	1	$8,000	$8,000	
Subtotal of Construction					**$74,000**
Remedial Action					
Pilot Testing	lump sum	1	$50,000	$50,000	
Bioremediation enhancing agents	pound	20000	$2.00	$40,000	
Injection event (labour, materials, mobilization)	day	20	$9,500	$190,000	
Subtotal of Remedial Action					**$280,000**
Mobilization (5%)	percent of total	0.05	$354,000	$17,700	$17,700
Adminstration (5%)	percent of total	0.05	$354,000	$17,700	$17,700
Engineering (10%)	percent of total	0.1	$354,000	$35,400	$35,400
Contingency (20%)	percent of total	0.2	$354,000	$70,800	$70,800
Total Capital Costs					**$495,600**
Operation&Mantenance (Annualized)					
Maintenance injections	day	7	$9,500	$66,500	
Bioremediation enhancing agents	pound	10000	$2.00	$20,000	
Bioremediation monitoring-additional requirements	lump sum	1	$8,000	$8,000	
Subtotal of O&M					**$94,500**
Adminstration (5%)	percent of total	0.05	$94,500	$4,725	$4,725
Total Annual O&M					**$99,225**
O&M Present Worth (for 4 years)					**$368,829**
Total Present Worth for Comparison					**$864,429**

Preliminary Costs for Comparison Purposes
LARC 60 Maintenance Area Feasibility Study
Fort Story, VA

Alternative 4 Pump and Treat					
Description	Unit	Quantity	Labor Material & Equipment Cost	Subtotal	Total
Remediation System Construction					
Well installation (30-ft hollow-stem auger, includes asphalt cutting)	each	30	$2,200	$66,000	
Piping installation (excavation/backfill included)	linear foot	1900	$22	$41,800	
Storage Tank	each	1	$10,000	$10,000	
Well pump installation	each	30	$2,200	$66,000	
Pump house installation	square ft	225	$112	$25,200	
Air compressor	each	6	$5,000	$30,000	
Air stripper	each	1	$10,000	$10,000	
Flare system	each	1	$100,000	$100,000	
Electrical System	lump sum	1	$10,000	$10,000	
Soil cuttings and purge groundwater disposal	lump sum	1	$8,000	$8,000	
Subtotal of Construction					**$367,000**
Remedial Action					
Pumping electricity useage	month	12	$1,200	$14,400	
Pump system operation	hour	416	$23	$9,755	
Subtotal of Remedial Action					**$24,155**
Mobilization (5%)	percent of total	0.05	$391,155	$19,558	$19,558
Adminstration (5%)	percent of total	0.05	$391,155	$19,558	$19,558
Engineering (10%)	percent of total	0.1	$391,155	$39,116	$39,116
Contingency (20%)	percent of total	0.2	$391,155	$78,231	$78,231
Total Capital Costs					**$547,617**
Operation&Mantenance (Annualized)					
Pumping electricity useage	month	12	$1,200	$14,400	
Pump system operation	hour	416	$23	$9,755	
Pump system Maintenance	lump sum	1	$10,000	$10,000	
Monitoring of influent/effluent	lump sum	1	$10,000	$10,000	
Subtotal of O&M					**$44,155**
Adminstration (5%)	percent of total	0.05	$44,155	$2,208	$2,208
Total Annual O&M					**$46,363**
O & M Present Worth (for 12 years)					**$461,497**
Total Present Worth for Comparison					**$1,009,114**

TABLE 6
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	Well ID and Results																RBCs (1)
	6MW-1				6MW-2				6MW-3S				6MW-3D				
	1995	2000	2003	2004	1995	2000	2003	2004	1995	2000	2003	2004	1995	2000	2003	2004	
Acetone	5 U	5 U	NT	NT	5 U	NT	NT	**270 D**	5 U	5 U	5 U	**17 J**	5 U	NT	5 U	**3.3**	550
Benzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	**0.6 J**	0.5 U	5 U	NT	5 U	0.5 U	0.34
Bromodichloromethane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.17
2-Butanone (MEK)	5 U	5 U	NT	NT	5 U	NT	NT	**21**	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	**2.5**	700
Carbon disulfide	5 U	5 U	NT	NT	5 U	NT	NT	**0.83**	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	100
Chloroform	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.15
Chloromethane	5 U	5 U	NT	NT	5 U	NT	NT	**0.23 JB**	5 U	5 U	5 U	**0.84 J**	5 U	NT	5 U	**0.21 J**	19
Cyclohexane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	---
Dibromochloromethane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.13
1,2-Dichlorobenzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	27
1,1-DCA	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	80
1,1-DCE	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	**1.3 J**	5 U	NT	5 U	0.5 U	35
cis 1,2-DCE	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	**2 J**	**1 J**	**100**	5 U	NT	5 U	**0.33 J**	6.1
trans 1,2-DCE	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	**0.87 J**	5 U	NT	5 U	0.5 U	12
Ethylbenzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	130
Isopropyl benzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	---
Methylcyclohexane	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	630
Methylene chloride	5 U	5 U	NT	NT	5 U	NT	NT	**0.52 B**	5 U	5 U	5 U	**3.3 JB**	5 U	NT	5 U	**0.47 JB**	4.1
MIBK	5 U	**50**	NT	NT	5 U	NT	NT	2.5 U	5 U	**44**	13 U	2.5 U	5 U	NT	13 U	2.5 U	630
Styrene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	160
Tetrachloroethene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	**0.4 J**	**62**	5 U	NT	5 U	0.5 U	0.1
Toluene	5 U	5 U	NT	NT	5 U	NT	NT	**0.29**	5 U	5 U	**0.8 J**	0.5 U	5 U	NT	**0.9 JB**	**0.42 J**	75
1,2,4-Trichlorbenzene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 U	5 U	5 U	0.5 U	5 U	NT	5 U	0.5 U	0.72
Trichloroethene	5 U	5 U	NT	NT	5 U	NT	NT	0.5 U	5 u	**1.3 J**	**1 J**	**140**	5 U	NT	5 U	0.5 U	0.026
Vinyl chloride	5 U	10 U	NT	NT	10 U	NT	NT	0.5 U	10 U	**3.1 J**	**1 J**	**9.7**	10 U	NT	5 U	**0.2 J**	0.015
Xylenes	5 U	10 U	NT	NT	5 U	NT	NT	1 U	5 U	10 U	5 U	1 U	5 U	NT	5 U	1 U	21

Notes:
(1) EPA Region III Risk-based Concentration Criteria for Tap Water
NT - Not tested
J - Estimated concentration (result between MDL and PQL for organics)
B - Detected in associated method blank
Organics detected are bolded and italicized.
Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

TABLE 6
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	6MW-4				6MW-5S		6MW-5D		6MW-6		6MW-7		6MW-8		6MW-9		RBCs (1)
	1995	2000	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	2003	2004	
Acetone	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	550
Benzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	**0.2 J**	0.5 U	0.34
Bromodichloromethane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.83**	5 U	0.5 U	5 U	0.5 U	0.17
2-Butanone (MEK)	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0. 5U	5 U	0. 5U	5 U	0. 5U	700
Carbon disulfide	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	100
Chloroform	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**3.3**	5 U	0.5 U	5 U	0.5 U	0.15
Chloromethane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.18 J**	19
Cyclohexane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	---
Dibromochloromethane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.12 J**	5 U	0.5 U	5 U	0.5 U	0.13
1,2-Dichlorobenzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	27
1,1-DCA	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	80
1,1-DCE	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	35
cis 1,2-DCE	5 U	5 U	5 U	NT	5 U	**1.1**	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	**0.15 J**	5 U	0.5 U	6.1
trans 1,2-DCE	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	12
Ethylbenzene	5 U	5 U	5 U	NT	5 U	0. 5U	5 U	0.5 U	5 U	0. 5U	5 U	0. 5U	5 U	0. 5U	5 U	0.5 U	130
Isopropyl benzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	---
Methylcyclohexane	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	630
Methylene chloride	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	**0.2 J**	5 U	**0.15 J**	5 U	**0.14 J**	5 U	**0.44 JB**	4.1
MIBK	5 U	**19**	13 U	NT	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	13 U	2.5 U	630
Styrene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	160
Tetrachloroethene	5 U	5 U	5 U	NT	5 U	**0.84**	5 U	0.5 U	5 U	0.5 U	**11**	**0.49 J**	5 U	0.5 U	5 U	0.5 U	0.1
Toluene	5 U	5 U	**0.6 J**	NT	**1 JB**	0.5 U	**1 JB**	0.5 U	**1 JB**	0.5 U	**1 JB**	**0.1 J**	**0.7 J**	0.5 U	**0.5 JB**	**0.15 J**	75
1,2,4-Trichlorbenzene	5 U	5 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	0.72
Trichloroethene	5 U	5 U	5 U	NT	5 U	**1.7**	5 U	**0.10 JB**	5 U	0.5 U	5 U	0.5 U	**0.5 J**	**0.15 J**	5 U	0.5 U	0.026
Vinyl chloride	10 U	10 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	0.015
Xylenes	10 U	10 U	5 U	NT	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	5 U	0.5 U	21

Notes:
(1) EPA Region III Risk-based Concentration Criteria for Tap Water
NT - Not tested
J - Estimated concentration (result between MDL and PQL for organics)
B - Detected in associated method blank
Organics detected are bolded and italicized.
Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

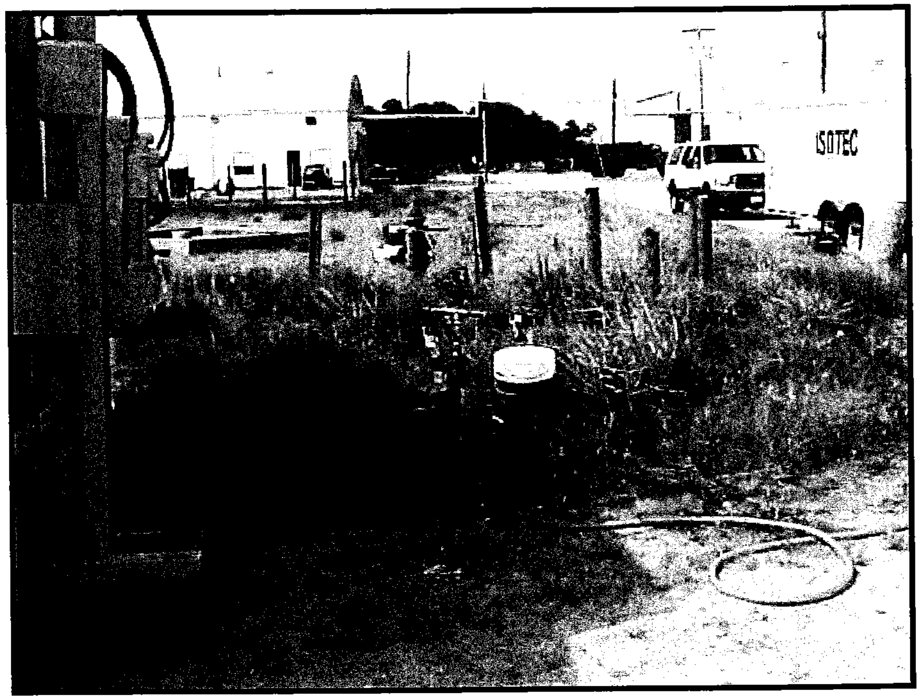
TABLE 6
MONITORING WELL GROUNDWATER RESULTS
LARC 60 MAINTENANCE AREA

Parameters	6MW-10	6MW-11	MW-115				MW-117				MW-118				RBCs (1)
	2004	2004	1995	2000	2003	2004	1995	2000	2003	2004	1995	2000	2003	2004	
Acetone	**5.5**	0.5 U	5 U	5 U	5 U	**2.9**	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**3**	550
Benzene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.34
Bromodichloromethane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.17
2-Butanone (MEK)	**4**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**1.5 J**	700
Carbon disulfide	**0.22 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	100
Chloroform	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.15
Chloromethane	**0.31 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**0.26 J**	19
Cyclohexane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**2.7**	5 U	5 U	5 U	0.5 U	---
Dibromochloromethane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.13
1,2-Dichlorobenzene	0.5 U	0.5 U	5 U5	5 U	5 U	**0.16 J**	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	27
1,1-DCA	0.5 U	0.5 U	5 U	5 U	5 U	**0.34 J**	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	80
1,1-DCE	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	35
cis 1,2-DCE	0.5 U	0.5 U	5 U	5 U	5 U	**0.3 J**	**20**	**1,900**	**22**	**24**	5 U	5 U	5 U	0.5 U	6.1
trans 1,2-DCE	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**0.25 J**	5 U	5 U	5 U	0.5 U	12
Ethylbenzene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	**66**	**76**	**29**	**6.8**	5 U	5 U	5 U	0.5 U	130
Isopropyl benzene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**6.2**	5 U	5 U	5 U	0.5 U	---
Methylcyclohexane	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**16**	5 U	5 U	5 U	0.5 U	630
Methylene chloride	**0.45 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	**0.43 JB**	4.1
MIBK	2.5 U	0.5 U	5 U	13 U	13 U	2.5 U	5 U	250 U	13 U	**4**	5 U	5 U	13 U	2.5 U	630
Styrene	**0.12 J**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	50 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	160
Tetrachloroethene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	**8.5**	50 U	**2 J**	**0.67 J**	5 U	5 U	5 U	0.5 U	0.1
Toluene	**0.36 J**	**0.17 J**	5 U	5 U	**0.7 J**	0.5 U	**68**	**310**	**1 JB**	**0.15 J**	5 U	5 U	**1 JB**	**0.27 J**	75
1,2,4-Trichlorbenzene	**0.15 JB**	0.5 U	5 U	5 U	5 U	0.5 U	5 U	50 U	5 U	0.5 U	5 U	5 U	5 U	0.5 U	0.72
Trichloroethene	0.5 U	0.5 U	5 U	5 U	5 U	0.5 U	**18**	50 U	**1 J**	0.5 U	5 U	5 U	5 U	0.5 U	0.026
Vinyl chloride	0.5 U	0.5 U	10 U	10 U	5 U	0.5 U	10 U	**8.6 J**	5 U	0.5 U	10 U	10 U	5 U	0.5 U	0.015
Xylenes	0.5 U	0.5 U	5 U	10 U	5 U	0.5 U	**290**	**450**	**130**	**65**	5 U	10 U	5 U	0.5 U	21

Notes:
(1) EPA Region III Risk-based Concentration Criteria for Tap Water
NT - Not tested
J - Estimated concentration (result between MDL and PQL for organics)
B - Detected in associated method blank
Organics detected are bolded and italicized.
Concentrations above EPA Region III RBCs for tap water are bolded and shaded.

FEASIBILITY STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

GROUNDWATER PILOT STUDY REPORT
LARC 60 MAINTENANCE AREA



Installation Restoration Program
Fort Story, Virginia

U.S. Army Corps of Engineers
Baltimore District

and

U. S. Army Transportation Center
Fort Eustis, Virginia

November 2004

0285-900-300

TABLE OF CONTENTS

Groundwater Pilot Study Report

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Malcolm Pirnie, Inc. was contracted by the U.S. Army Corps of Engineers (USACE), Baltimore District to conduct a Groundwater Pilot Study at the LARC 60 Maintenance Area site at Fort Story, Virginia under Contract DACA31-00-D-0043.

Benzene, ethylbenzene, toluene, and xylenes (BTEX), methyl isobutyl ketone (MIBK), tetrachloroethene (PCE), trichloroethene (TCE), cis 1,2-dichloroethene (cis 1,2-DCE), and vinyl chloride were detected in groundwater above EPA risk screening criteria (EPA RBCs and/or USEPA MCLs) in previous investigations conducted at the site. These volatile organic compounds will be referred to as the contaminants of concern (COCs), hereafter.

The Pilot Study was conducted to evaluate the effectiveness of in-situ chemical oxidation using sodium permanganate ($NaMnO_4$) for reducing the concentration of the COCs in the groundwater in the former underground storage tank (UST) area of the site. The treatment area is located just north of the former UST Area. This area was chosen due to its relatively high concentrations of COCs, the variety of contaminants detected, and its designation as the probable, former source for site contamination.

This Pilot Study was conducted in accordance with the *Work Plan Addendum, Treatability Study, LARC 60 Maintenance Area, Fort Story,* dated May 2003 prepared by Malcolm Pirnie. The goals of the Pilot Study were as follows:

- Gather data to evaluate the effectiveness of chemical oxidation using a permanganate compound (sodium or potassium) as a remedial technology at the site.
- Gather data on contaminant rebound within the study area.
- Gather data to evaluate the effectiveness of chemical oxidant delivery via direct push methods.
- Provide initial steps toward remediating groundwater by reducing levels of COCs in the test area.
- Quantify (via groundwater sampling) post-injection contaminant concentrations including any rebound effects.
- Quantify oxidant quantity for full-scale implementation of chemical oxidation.

2.0 IN SITU CHEMICAL OXIDATION TREATMENT CONCEPT

2.1 Selection of In Situ Chemical Oxidation using Permanganate

In-situ chemical oxidation (ISCO) involves the delivery and distribution of oxidants and other amendments into the subsurface to transform contaminants of concern into innocuous end products such as carbon dioxide (CO_2), water, and inorganic compounds. The primary advantages of ISCO technologies are their relatively low cost and short treatment times. Since the reaction is near immediate, treatment is far more rapid than biological techniques and can be faster than thermal or vapor recovery technologies. Also, the technology does not generate large volumes of waste material that must be disposed of and/or treated. ISCO generally provides the greatest benefit for localized source areas since it is capable of treating very high concentrations of contaminants rapidly. ISCO typically becomes prohibitively expensive over large treatment areas. The appropriateness of ISCO technology at a site depends on matching the oxidant and delivery system to the site contaminants and site conditions.

The most common oxidants utilized for ISCO are hydrogen peroxide (Fenton's reagent), potassium permanganate ($KMnO_4$), $NaMnO_4$, sodium persulfate, and ozone. Sodium permanganate was selected as the oxidant for the Pilot Study for several reasons:

- The other common oxidants are stronger than permanganate; therefore, they degrade more rapidly in the environment. Permanganate is more stable and is expected to remain active in the subsurface for weeks or months.

- There is a higher risk of excess pressure building in the subsurface by using other oxidants (e.g., Fenton's reagent) rather than permanganate.

- Permanganate is effective over a wider range of pH than Fenton's reagent, which is most effective in acidic conditions

The main reason for the selection of $NaMnO_4$ was that unreacted $KMnO_4$ in solution is relatively stable; it can diffuse into media with low permeabilities (e.g., silt, fine sands) over time, further enhancing oxidant delivery to hard-to-treat contaminated zones. Application of excess

$NaMnO_4$ will allow for diffusion of permanganate into the matrix at the same time as contamination is diffusing out of the matrix (i.e., the reactants will be moving towards each other), speeding the treatment of contamination sorbed to the sand matrix.

2.2 Mechanics of ISCO using Sodium Permanganate

The oxidation of PCE (C_2Cl_4) and TCE (C_2Cl_3H) by $NaMnO_4$ is governed by the following reactions:

$$C_2Cl_4 + 2NaMnO_4 \rightarrow 2\ CO_2\ (aq) + 2NaO_2\ (s) + 2NaCl + Cl_2$$
$$C_2Cl_3H + 2NaMnO_4 \rightarrow 2\ CO_2\ (aq) + 2NaO_2\ (s) + 2NaCl + HCl$$

Chemical oxidation occurs at both the soil interface and free-phase interface (for NAPL situations) and within the interstitial pore spaces in the saturated subsurface (for dissolved compounds).

$NaMnO_4$ can oxidize a wide range of inorganic and organic compounds including:

- Chlorinated solvents
- Polynuclear aromatic hydrocarbons (PAHs)
- Phenolics (including creosols)
- Cyanides

Organic compounds that contain carbon-carbon double bonds (alkenes) are more readily oxidized by permanganate than compounds having single carbon-carbon bonds (alkanes). Thus, permanganate is more effective at remediating chlorinated organics consisting of TCE or PCE rather than 1,1,1-trichloroethane (TCA).

Environmental parameters that influence the rate and degree of $NaMnO_4$ oxidations include:

- pH (effective over a range of 3 to 12 with an optimum near 7)
- Temperature
- Contact (or reaction) time
- Oxidant concentration

2.3 Potential Limitations

Some potential limitations to the use of $NaMnO_4$ include the following:

- The potential to alter subsurface biogeochemistry and locally mobilize co-contaminants (e.g., redox sensitive metals such as Cr). This issue is not of concern at the site.
- The potential for manganate (Mn^{4+}) to be reduced to dissolved divalent manganese (Mn^{2+}) under low-pH or redox conditions.

Hazardous intermediate compounds may be formed due to incomplete oxidation caused by insufficient quantity of the oxidant, the presence of interfering compounds (natural organic-rich media, iron and/or manganese) that consume the reagents, and/or inadequate mixing or contact time between contaminant and oxidizing agent.

The by-products (HCl, Cl_2, etc.) released into the subsurface are generally not considered harmful in the environment. However, it is important to understand the fate of the primary by-products in order to minimize adverse impacts to the treatment zone.

- **CO_2 – carbon dioxide** will combine with water to form the carbonate series and lower the pH of the ground water.
- **Cl_2 – chlorine gas** is highly reactive, and it will readily combine with water to form hypochlorous acid (HOCl) and hypochlorite (OCl^-). These two compounds are also very strong oxidants.
- **HCl – hydrochloric acid** will be neutralized in carbonate environments.
- **MnO_2 – manganese dioxide** will precipitate out, coating the subsurface. The buildup of manganese dioxide, and other manganese oxides that may be formed, may reduce matrix permeability over time.

3.0 Pilot Study $NaMnO_4$ Injections

The Pilot Study consisted of two phases of $NaMnO_4$ solution application. The methods followed and results obtained for each phase are described in detail in the following sections.

3.1 Permanganate Injection Methodology

Malcolm Pirnie contracted with In-Situ Oxidative Technologies, Inc. (ISOTEC) to perform the $NaMnO_4$ injections throughout the course of the Pilot Study. $NaMnO_4$ exists as either a fine powder that is dissolved in water prior to injection or liquid concentrate available in higher concentrations. Liquid concentrate was used for both injection events at the site. ISOTEC used a recirculating mixer assembly to mix the $NaMnO_4$ with potable water obtained from a nearby fire hydrant. Although the Pilot Work Plan Addendum specified use of 34 pounds of permanganate, this applied to the amount of potassium permanganate that would have been used. Since $NaMnO_4$ was used instead, an equivalent $NaMnO_4$ dose equal to110 pounds (lbs) per point was utilized. Therefore, 110 lbs (approximate 1% solution) of $NaMnO_4$ solution per point for both injections events was planned. However, due to the need for a higher dose for the second event (based on groundwater data after the 1st injection), approximately 550 lbs (8% solution) per point was injected during the 2nd event.

Photographs #1 through #3 (provided in **Appendix A**) present the permanganate batch preparation activities.

3.2 Injection Phases

1st Injection Event

The zone of treatment included an interval from 10 feet to 30 feet below land surface (bls) with the groundwater table present at a depth of approximately 10 feet bls. Five injection points located upgradient of monitoring well MW-117 (well with highest contaminant concentrations on-site) were utilized for delivery of the permanganate. Photograph #4 provided in **Appendix A** shows the geoprobe rig installing one of the injection points. Design of the injection pathway system consisted of temporary direct push injection points. Based on the thickness of the treatment zone (20 feet), each injection point was divided into five 4-foot intervals (10 to 14 feet bls, 14 to 18 feet bls, 18 to 22 feet bls, 22 to 26 feet bls, and 26 to 30 feet bls), with each interval receiving permanganate. The study consisted of the injection of approximately 85 gallons of reagents into each injection point interval. Oxidants were delivered into the subsurface under a constant low-pressure (20 to 30 psi) system in an effort to distribute materials in a homogeneous fashion through the injection interval. A flow rate of 4 to 5 gallons per minute was utilized for delivery of the oxidant into the subsurface.

The location of the injection points and monitoring wells are presented on **Figure 1.**

Photographs #5 through #8 present the permanganate pumping.

During the 1st injection event of the Pilot Study, approximately 2,125 gallons of a 1% solution of $NaMnO_4$ were injected at five injection points (425 gallons per point) on August 12 and 13, 2003. The volume of 2,125 gallons of the 1% $NaMnO_4$ solution equals approximately 550 lbs of permanganate delivered to the subsurface during the 1st injection event.

2nd Injection Event

The zone of treatment for the 2nd injection event was the same as the zone described for the 1st injection event.

The 2nd injection event consisted of the injection of approximately 55 gallons of reagents into each injection point interval. During the 2nd injection event of the Pilot Study, approximately 1,375 gallons of an 8% solution of $NaMnO_4$ were injected at five injection points (275 gallons per point) on May 13, 2004. The volume of 1,375 gallons of the 8% $NaMnO_4$ solution equals approximately 2,750 lbs of permanganate delivered to the subsurface during the 2nd injection event.

4.0 Pilot Study Monitoring

4.1 1st Injection Event Monitoring

Groundwater samples were collected from several monitoring wells and injection points prior to the 1st injection event at the site. In addition, a saturated soil sample was collected to assess the extent of sorbed contamination in the treatment area. A summary of these monitoring events is presented below.

Pre-Injection Monitoring Well Sampling

A temporary monitoring well (TW-01) was constructed approximately 60 feet downgradient of the injection points to monitor impacts of the permanganate injections over a period of time after completion of the injections. Prior to the injection events, this well was sampled and analyzed for iron, chlorides, total organic carbon (TOC), diesel and gasoline range petroleum-related organics (TPH DRO and TPH GRO), and the COCs. Iron (14.1 mg/L), chlorides (41 mg/L), and TOC (3.6 mg/L) were detected in TW-01 but no DRO, GRO, or VOCs were detected. The other downgradient well (MW-117) was sampled for iron, chlorides, and COCs. Iron (4.6 mg/L), chloride (16 mg/L), and several COCs (cis 1,2-DCE, PCE, TCE, and BTEX) were detected in the samples. Both wells were sampled on July 25, 2003. It should be noted that the VOC data presented for MW-117 was collected in January 2003. A summary of the data for the pre-injection monitoring is presented in **Table 1** while the analytical results are included in **Appendix B**

Pre-Injection Saturated Soil Sampling

A saturated soil sample was collected on July 25, 2003 during the installation of TW-01 to assess the extent of any sorbed contamination in the treatment area. The soil sample was analyzed for TOC, TPH DRO, TPH GRO, and the COCs. No TOC, DRO, GRO, or VOCs were detected. The analytical results are included in **Appendix B**

Injection Point Monitoring

Prior to the 1st injection event, samples were collected from five injection points and analyzed for chloride, ferrous iron, and field parameters (i.e., temperature, specific conductivity, turbidity, pH, and dissolved oxygen (DO)). A summary of the analytical and field data collected from the five injection points is presented in **Table 2** while the analytical results are included in **Appendix B**

4.2 2nd Injection Monitoring

Injection Point Monitoring

Prior to the 2nd injection event, samples were collected from five injection points and analyzed for chloride, ferrous iron, and field parameters (i.e., temperature, specific conductivity, turbidity, pH, and dissolved oxygen (DO)). A summary of the analytical and field data collected from the five injection points is presented in **Table 3** while the analytical results are included in **Appendix B**

4.3 Rebound Monitoring

It was anticipated that after the injections ceased, $NaMnO_4$ concentrations would gradually diminish to below detection and COC concentrations would gradually rise from below detection to detectable values. This rebound in COC concentrations is due to reverse diffusion and cross flow that can transport COCs into the treated zone from any untreated zones. Rebound monitoring was conducted to monitor the rate of $NaMnO_4$ dissipation, iron and chloride concentrations, and subsequent COC concentration rebound.

A summary of the rebound monitoring data after each injection event is provided below.

Rebound Monitoring – 1st Injection Event

Rebound monitoring was started immediately after the end of the 1st injection event through the collection of water samples from MW-117 and TW-01 weekly (for 6 weeks) for iron, chloride, $NaMnO_4$ presence observation, and field parameters (i.e., temperature, specific conductivity, turbidity, pH, and DO). On the 6th weekly monitoring event, the wells and the saturated soils were also sampled and analyzed for DRO, TOC, and the COCs. Rebound groundwater monitoring results for the 1st injection event is summarized in **Table 4.** The direct push saturated soil sample indicated the presence of only 5 ppb of total xylenes. No other VOCs or DRO were detected.

Graphs depicting the rebound results for each of the parameters (chlorides and iron) monitored weekly are included in **Appendix C.** A summary of the rebound monitoring is presented below.

<u>Chlorides</u>

Although the graphs presented in **Appendix C** show a slight upward trending in chlorides in MW-117 and TW-01 during the weekly monitoring events, the overall change (30% for MW-117 and 8% for TW-01) is very small indicating that the 1st injection event produced minimal oxidation of the COCs.

Iron

The graph in **Appendix C** indicate an initial drop in iron concentrations within the treatment zone followed by a rebound trending toward approximate pre-injection levels at week #6 of the monitoring. Permanganate reactions typically mobilize naturally-occurring metals and metal contaminants including iron. This indicates that minimal mobilization occurred.

COCs

A summary of the COCs detected during the pre-injection monitoring event and the post-injection #1 event at MW-117 is presented in the following table.

COC	Monitoring well MW-117 Data	
	Pre-injection	Post-Inj #1
Cis 1,2-DCE	22	190
Ethylbenzene	29	12
Isopropyl Benzene	5 U	7
PCE	2	5 U
TCE	1	5 U
Toluene	1	66
Xylenes	130	75
Notes: U – Not detected		

Results of comparison of the rebound monitoring to the pre-injection monitoring are varied. Although changes in concentrations were minimal, the concentrations of some COCs decreased (ethylbenzene, PCE, TCE, and xylenes) while others increased (cis 1,2-DCE, isopropyl benzene, and toluene).

Based on the results of the chloride, iron, and COC analysis, it was determined that injection of a 1% solution of sodium permanganate was insufficient to oxidize the groundwater contaminants at the site. Therefore, as previously discussed the permanganate solution was increased to approximately 8% for the 2nd injection event.

Rebound Monitoring – 2nd Injection Event

Rebound monitoring was started immediately after the end of the 2nd injection event through the collection of water samples from MW-117 and TW-01 weekly (for 4 weeks) for iron, chloride, $NaMnO_4$ presence observation, and field parameters (i.e., temperature, specific conductivity, turbidity, pH, and DO). On the 5th weekly monitoring event, MW-117 was only sampled and analyzed for the COCs and the field parameters. Due to lack of sorbed-phase contamination in the treatment area as indicated in the rebound monitoring conducted after the 1st injection event, no additional saturated soils were collected after the 2nd injection event.

Rebound groundwater monitoring results for the2nd injection event are summarized in **Table 5.**

Graphs depicting the rebound results for each of the parameters (chlorides and iron) monitored weekly are included in **Appendix B**. A summary of the rebound monitoring is presented below.

<u>Chlorides</u>

Although the graphs presented in **Appendix C** show a significant increase in chloride concentrations in MW-117 and TW-01 during the weekly monitoring events, as compared to the pre-injection levels.

The graph for MW-117 indicates an initial increase of chlorides to 205 mg/L followed by a decrease to 12 mg/l (concentration consistent with background) over a 3-week period. This indicates a rapid oxidation process followed by a slowdown due to the continued downgradient movement of the permanganate and the dissipation of the permanganate and its by-products in the area near MW-117.

The graph for TW-01 indicates an increase in chloride concentrations as permanganate reaches this area (TW-01 is approximately 60 feet downgradient of the injection points). The high concentrations indicate oxidation of COCs in this area during the monitoring period. As noted by the chloride concentration of 351 mg/L, oxidation appears high even after the 4th week after injection.

<u>Iron</u>

The graph in **Appendix C** indicate an initial drop in iron concentrations in

MW-117 followed by a rebound trending toward approximate pre-injection levels at week #4 of the monitoring. Iron concentrations increased during the 4-week monitoring period in TW-01 but concentrations were similar to pre-injection levels. Permanganate reactions typically mobilize naturally-occurring metals and metal contaminants including iron. The post-injection #2 data indicates that minimal mobilization occurred.

COCs

A summary of the COCs detected during the pre-injection monitoring event (post-injection #1 data) and the post-injection #2 event at MW-117 is presented in the following table.

COC	Monitoring well MW-117 Data	
	Post-Inj #1	**Post-Inj #2**
Cis 1,2-DCE	190	24
Trans 1,2-DCE	5 U	0.25
Cyclohexane	5 U	2.7
Ethylbenzene	12	6.8
Isopropyl Benzene	7	6.2
Methylcyclohexane	5 U	16
4-Methyl-2-pentanone	5 U	4
PCE	5 U	0.67
TCE	5 U	5 U
Toluene	66	0.15
Xylenes	75	65

Notes:
U – Not detected

Results of comparison of the rebound monitoring after the 2nd injection to the pre-injection monitoring (post-injection #1 data) are varied. Although changes in concentrations were minimal, the concentrations of some COCs decreased (cis 1,2-DCE, ethylbenzene, isopropyl benzene, toluene, and xylenes) while others increased (trans 1,2-DCE, several cyclohexanes, 4-methyl-2-pentanone, and PCE).

4.4 Site-wide Groundwater Monitoring

In addition to the rebound monitoring conducted at MW-117 and TW-01 within the treatment zone of the pilot study, a site-wide groundwater monitoring event was conducted in 2004 to assess the current VOC concentrations across the site. A copy of the analytical results are provided in **Appendix B**.

As shown in **Table 6**, VOCs have been detected above the EPA risk-based concentrations (RBCs) for tap water in seven monitoring wells across the site with the highest concentrations detected in wells MW-117 which is located directly downgradient of the former leaking underground storage tank and 6MW-3S which is located further downgradient but has the highest concentrations. However, exceedences of the USEPA maximum contaminant levels (MCLs) for drinking water are limited to only three wells (MW-117, 6MW-3S, and 6MW-3D). The lateral extent of the VOC plume that has concentrations above the EPA RBCs for tap water is presented on **Figure 2.** This lateral extent data will be utilized in the remedial design to establish the potential treatment areas for the site.

5.0 Conclusions

Based on the results of the chloride, iron, and COC analysis, it was determined that injection of an 8% solution of sodium permanganate was sufficient to oxidize the groundwater contaminants at the site. However, a higher concentration of permanganate may be necessary to destroy the residual COCs at the site due to their relatively low concentration (less than 100 ug/L).

GROUNDWATER PILOT STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

TABLE 1

PRE-INJECTION #1 RESULTS - MONITORING WELLS
LARC 60 SITE, FORT STORY, VA

Parameter	MONITORING WELL	
	MW-117	TW-01
ANALYTICAL LABORATORY RESULTS		
Chloride (mg/L)	16	41
Ferrous Iron (mg/L)	4.6	14.1
TPH DRO and GRO	NT	ND
COCs (µg/L)		
cis 1,2-DCE	22	ND
Ethylbenzene	29	ND
PCE	2	ND
Toluene	1	ND
TCE	1	ND
Xylenes	130	ND
FIELD PARAMETER RESULTS		
pH	4.79	4.74
Specific Conductivity (µS/cm)	188	184
Turbidity (NTUs)	16	288
Dissolved Oxygen (ppm)	1.27	0
Temperature (°C)	22.3	20.3

Notes:
NT - Not Tested

Unit Definitions:
mg/L = milligrams per liter
µS/cm = micro Siemens per centimeter
NTUs = Nephelometric Turbidity Units
ppm = parts per million
°C = degrees Centigrade

TABLE 2

PRE-INJECTION #1 RESULTS - INJECTION POINTS
LARC 60 SITE, FORT STORY, VA

Parameter	INJECTION POINT				
	Point #1	Point #2	Point #3	Point #4	Point #5
ANALYTICAL LABORATORY RESULTS					
Chloride (mg/L)	8.18	8.48	8.28	9.43	7.17
Ferrous Iron (mg/L)	3.92	13.4	2.04	1.88	1.72
FIELD PARAMETER RESULTS					
pH	5.78	5.72	5.69	6.12	5.23
Specific Conductivity (µS/cm)	291	182	150	166	177
Turbidity (NTUs)	> 999	> 999	503	525	457
Dissolved Oxygen (ppm)	1.19	1.02	1.83	1.38	1.32
Temperature (°C)	25.8	25.0	24.7	25.2	24.7

Notes:

Unit Definitions: mg/L = milligrams per liter
µS/cm = micro Siemens per centerimeter
NTUs = Nephelometric Turbidity Units
ppm = parts per million
°C = degrees Centigrade

TABLE 3
PRE-INJECTION #2 RESULTS - INJECTION POINTS
LARC 60 SITE, FORT STORY, VA

Parameter	INJECTION POINT				
	Point #1	Point #2	Point #3	Point #4	Point #5
ANALYTICAL LABORATORY RESULTS					
Chloride (mg/L)	12	9	14	16	19
Ferrous Iron (mg/L)	1.84	1.05	1.1	13.77	13.25
FIELD PARAMETER RESULTS					
pH	5.70	6.05	5.60	4.71	5.01
Specific Conductivity (µS/cm)	192	175	189	183	223
Turbidity (NTUs)	185	89	204	151	585
Dissolved Oxygen (ppm)	0.62	1.37	1.55	< 1	9.34
Temperature (°C)	19.2	19.7	19.4	19.6	19.3

Notes:

Unit Definitions: mg/L = milligrams per liter
µS/cm = micro Siemens per centerimeter
NTUs = Nephelometric Turbidity Units
ppm = parts per million
°C = degrees Centigrade

TABLE 4
REBOUND MONITORING - POST INJECTION #1
LARC 60 SITE, FORT STORY, VA

Parameter	MONITORING WELL AND DATE SAMPLED (IN 2003)											
	MW-117						TW-01					
	22-Aug	29-Aug	5-Sep	16-Sep	23-Sep	17-Oct	22-Aug	29-Aug	5-Sep	16-Sep	23-Sep	17-Oct
ANALYTICAL LABORATORY RESULTS												
Chloride (mg/L)	8.99	11.4	11	9.84	9.46	11.7	34.2	35	34.2	35.7	34.7	37
Ferrous Iron (mg/L)	6.95	7.94	6.6	1.9	3.8	8.25	8.29	8.16	2.38	2.48	5.45	6.65
TOC (mg/L)	NT	NT	NT	NT	NT	27.91	NT	NT	NT	NT	NT	25.43
TPH DRO (mg/L)	NT	NT	NT	NT	NT	2.5	NT	NT	NT	NT	NT	2.5 U
COCs (µg/L)												
cis 1,2-DCE	NT	NT	NT	NT	NT	190	NT	NT	NT	NT	NT	5 U
Ethylbenzene	NT	NT	NT	NT	NT	12	NT	NT	NT	NT	NT	5 U
Isopropyl Benzene	NT	NT	NT	NT	NT	7	NT	NT	NT	NT	NT	5 U
Toluene	NT	NT	NT	NT	NT	66	NT	NT	NT	NT	NT	0.8 J
Xylenes	NT	NT	NT	NT	NT	75	NT	NT	NT	NT	NT	5 U
FIELD PARAMETER RESULTS												
pH	6.55	6.84	6.88	6.22	5.98	6.12	6.79	6.95	6.85	6.41	6.40	6.32
Specific Conductivity (µS/cm)	170	206	201	199	202	199	173	166	164	166	163	165
Turbidity (NTUs)	---	---	---	25	22	21	---	---	---	5	37	32
Dissolved Oxygen (ppm)	1.46	1.39	1.26	1.27	1.27	1.28	1.42	1.37	1.46	1.41	1.38	1.42
Temperature (°C)	24.6	24.9	22.1	23.7	23.6	22.4	23.3	23.8	22.0	21.3	23.0	21.7

Notes:

NT - Not Tested

Unit Definitions:

mg/L = milligrams per liter

µS/cm = micro Siemens per centimeter

NTUs = Nephelometric Turbidity Units

ppm = parts per million

°C = degrees Centigrade

TABLE 5
REBOUND MONITORING - POST INJECTION #2
LARC 60 SITE, FORT STORY, VA

Parameter	MONITORING WELL AND DATE SAMPLED (IN 2004)									
	MW-117					TW-01				
	28-May	7-Jun	14-Jun	18-Jun	17-Jul	28-May	7-Jun	14-Jun	18-Jun	17-Jul
ANALYTICAL LABORATORY RESULTS										
Chloride (mg/L)	205	124	107	12	NT	116	396	45	351	NT
Ferrous Iron (mg/L)	6.5	5.7	4.8	5.9	NT	4.7	6.1	6.4	7.3	NT
TOC (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
TPH DRO (mg/L)	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
COCs (µg/L)										
Cyclohexane	NT	NT	NT	NT	2.7	NT	NT	NT	NT	NT
cis 1,2-DCE	NT	NT	NT	NT	24	NT	NT	NT	NT	NT
trans 1,2-DCE	NT	NT	NT	NT	0.25 J	NT	NT	NT	NT	NT
Ethylbenzene	NT	NT	NT	NT	6.8	NT	NT	NT	NT	NT
Isopropyl Benzene	NT	NT	NT	NT	6.2	NT	NT	NT	NT	NT
Methylcyclohexane	NT	NT	NT	NT	16	NT	NT	NT	NT	NT
4-Methyl-2-pentanone	NT	NT	NT	NT	4	NT	NT	NT	NT	NT
PCE	NT	NT	NT	NT	0.67	NT	NT	NT	NT	NT
Toluene	NT	NT	NT	NT	0.15 J	NT	NT	NT	NT	NT
Xylenes	NT	NT	NT	NT	65	NT	NT	NT	NT	NT
FIELD PARAMETER RESULTS										
pH	6.47	6.53	6.38	6.50	6.09	6.14	6.03	5.85	5.98	NT
Specific Conductivity (µS/cm)	142	149	147	155	159	165	173	172	179	NT
Turbidity (NTUs)	< 30	< 30	164	---	5	410	290	235	---	NT
Dissolved Oxygen (ppm)	1.44	1.92	---	---	10.77	2.25	2.98	---	---	NT
Temperature (°C)	19.9	21.5	21.2	23.4	21.3	20.7	19.4	20.5	22.2	NT

Notes:

NT - Not Tested

Unit Definitions:

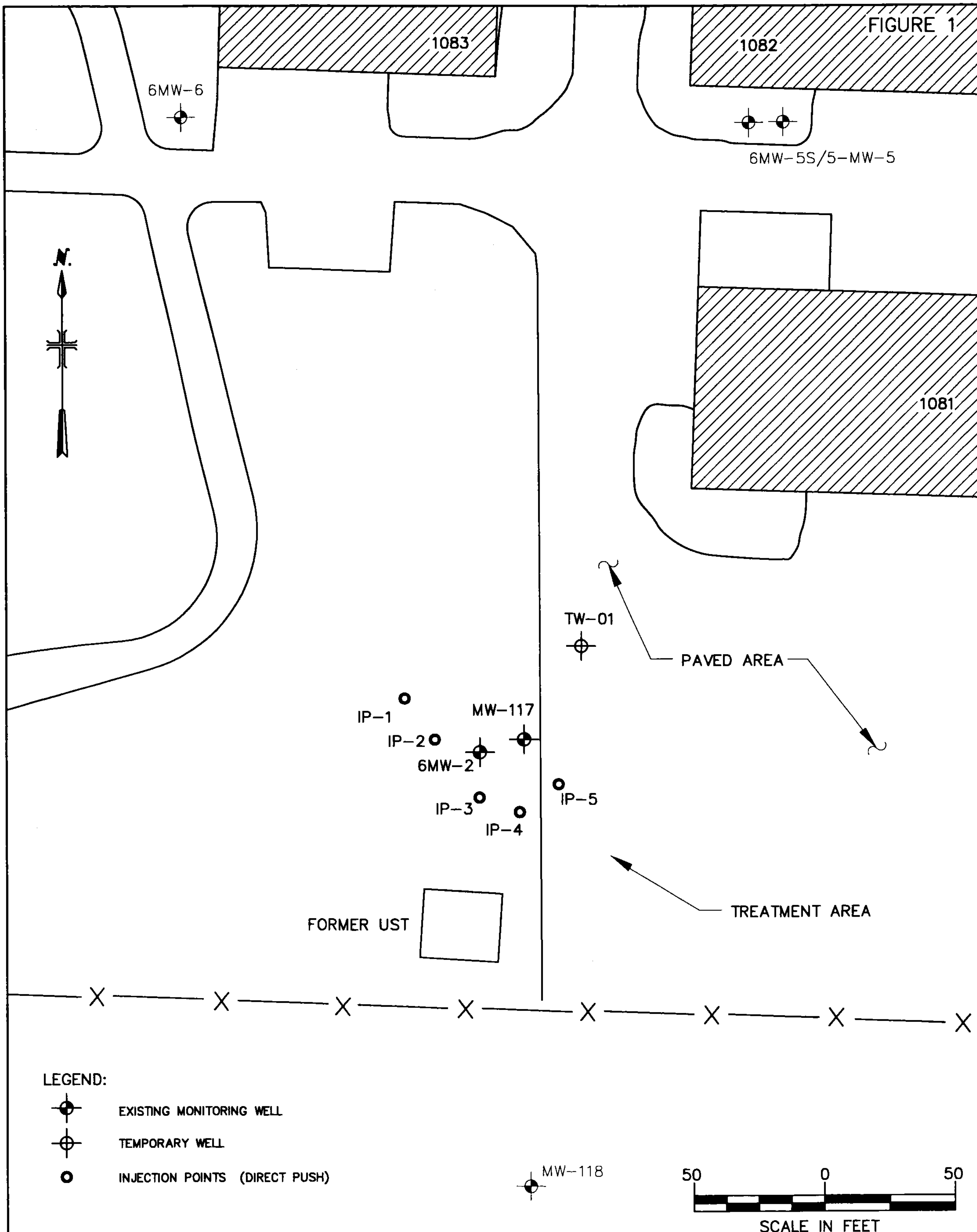
mg/L = milligrams per liter

µS/cm = micro Siemens per centimeter

NTUs = Nephelometric Turbidity Units

ppm = parts per million

°C = degrees Centigrade

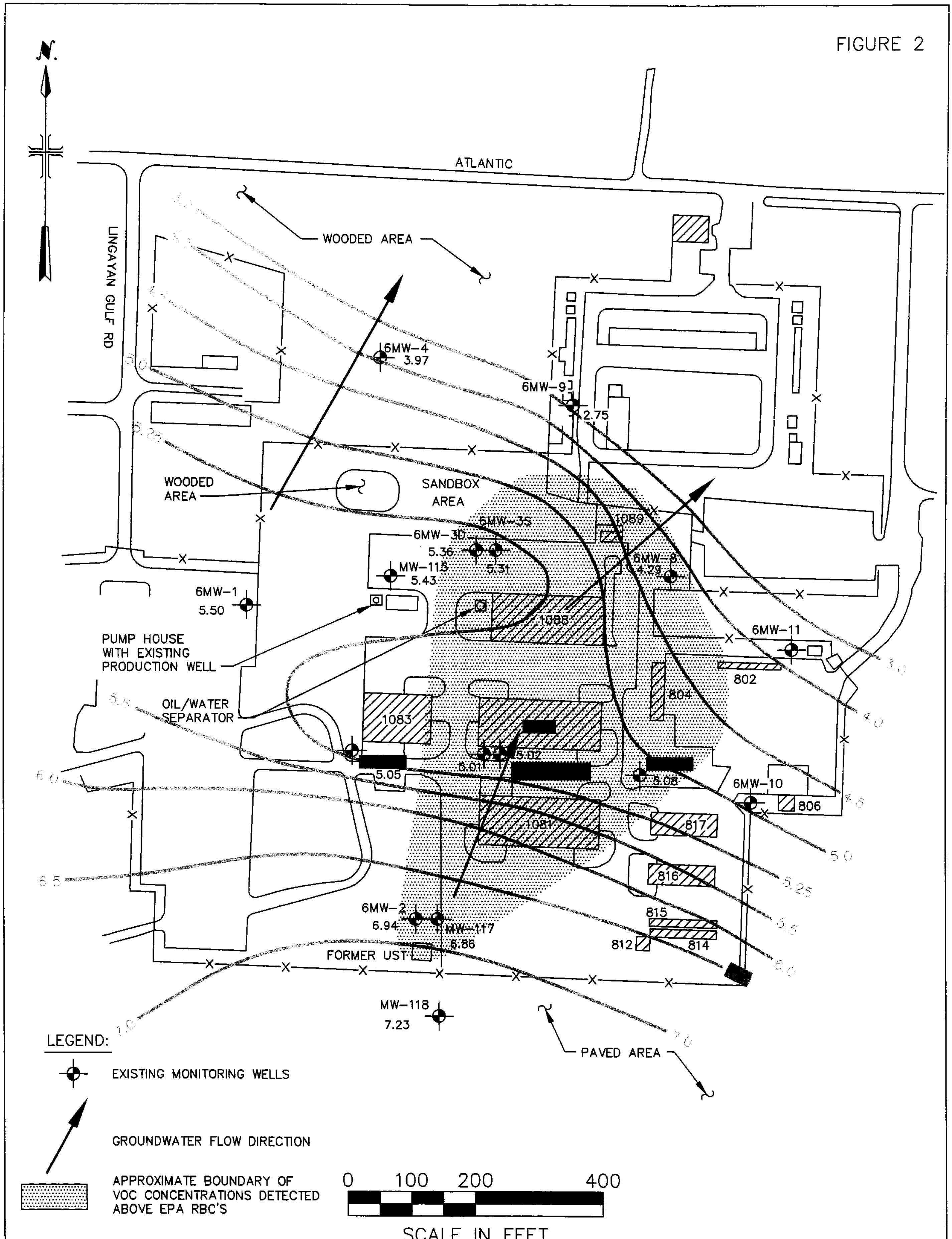


MALCOLM PIRNIE

FORT STORY, VIRGINIA
GROUNDWATER PILOT STUDY REPORT
TREATMENT AREA

MALCOLM PIRNIE, INC.

DEC 2004



MALCOLM PIRNIE

FORT STORY, VIRGINIA

GROUNDWATER PILOT STUDY REPORT

VOC PLUME MAP

MALCOLM PIRNIE, INC.

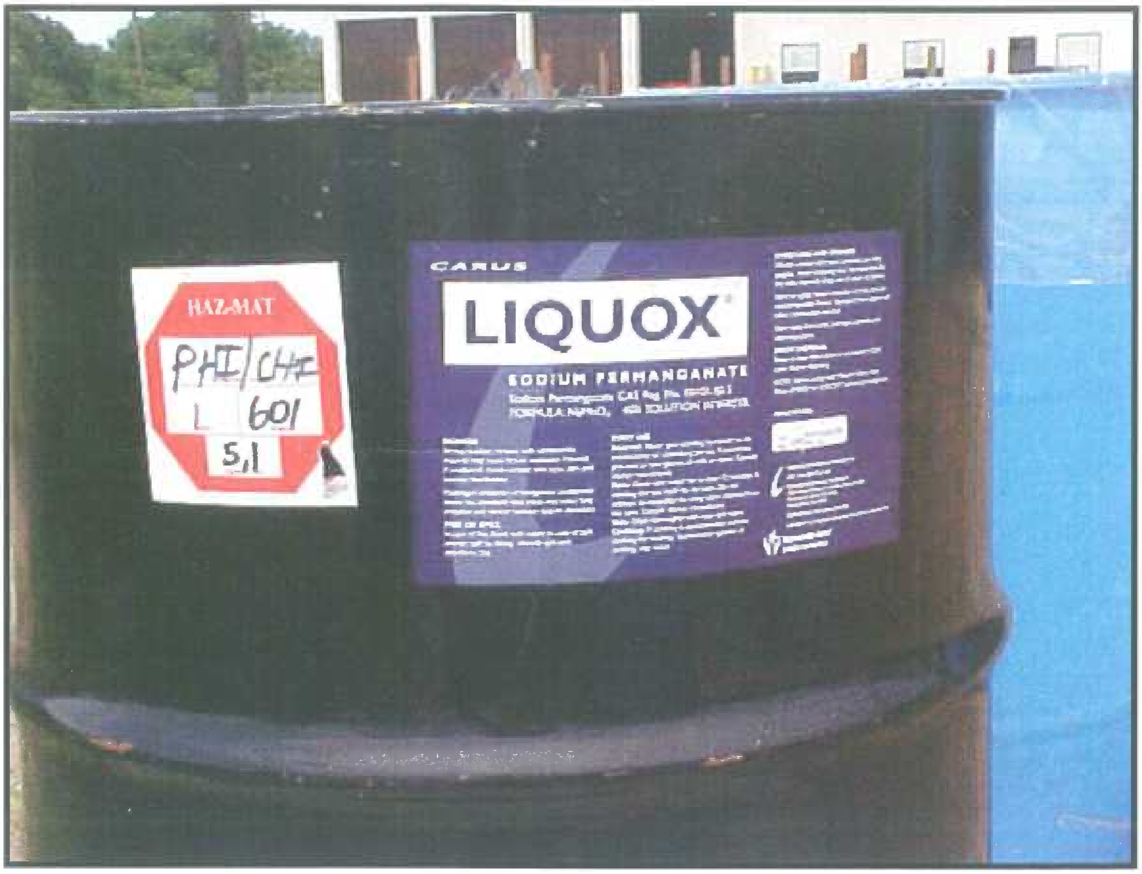
DEC 2004

XREFS: ;ES:None

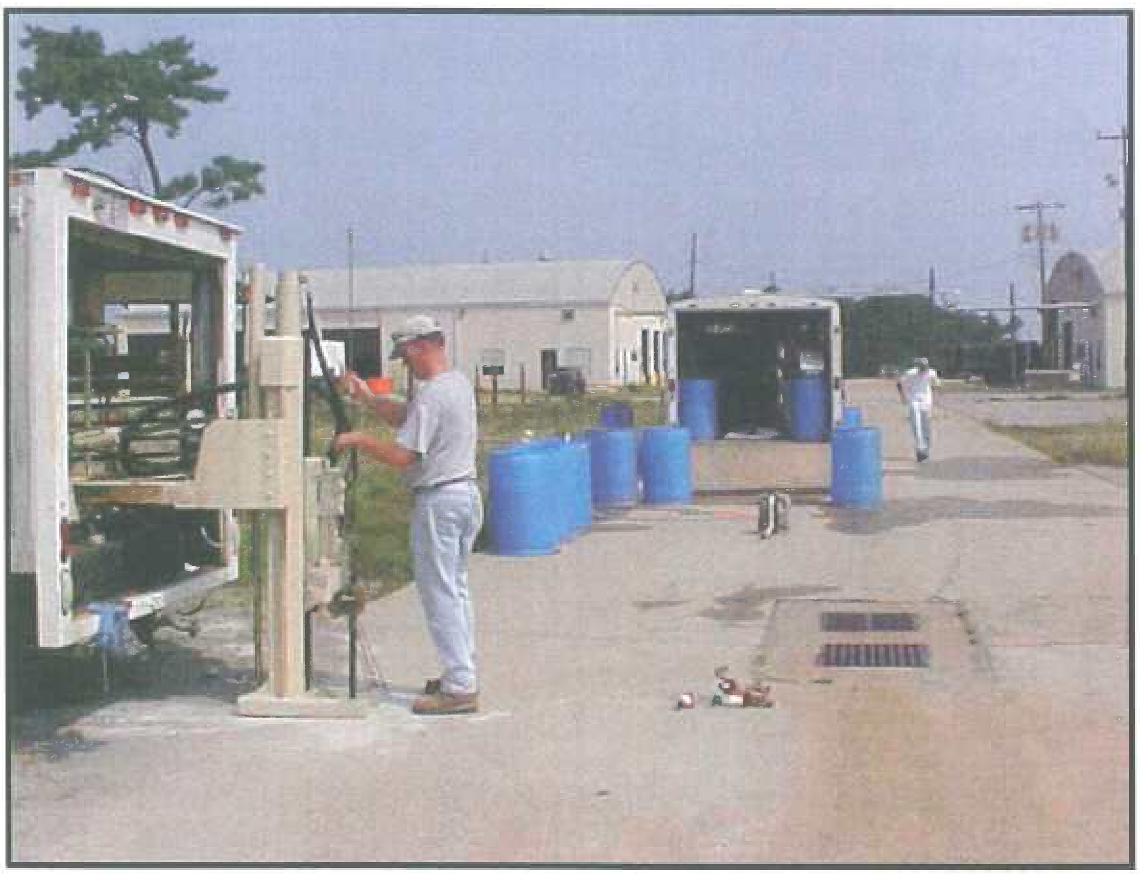
GROUNDWATER PILOT STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

PHOTOGRAPH #1 – PERMANGANATE BATCHES

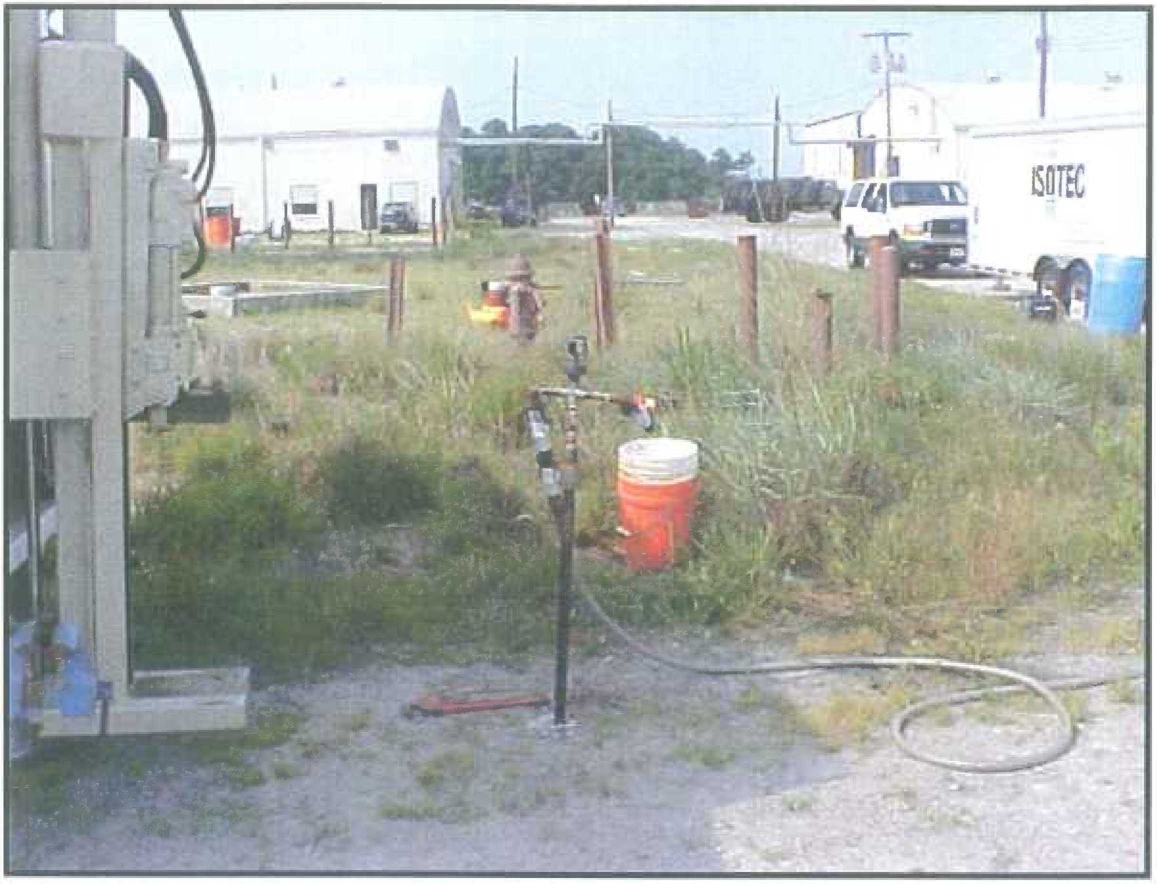
PHOTOGRAPH #2 – PEMANGANATE INTAKE PUMP



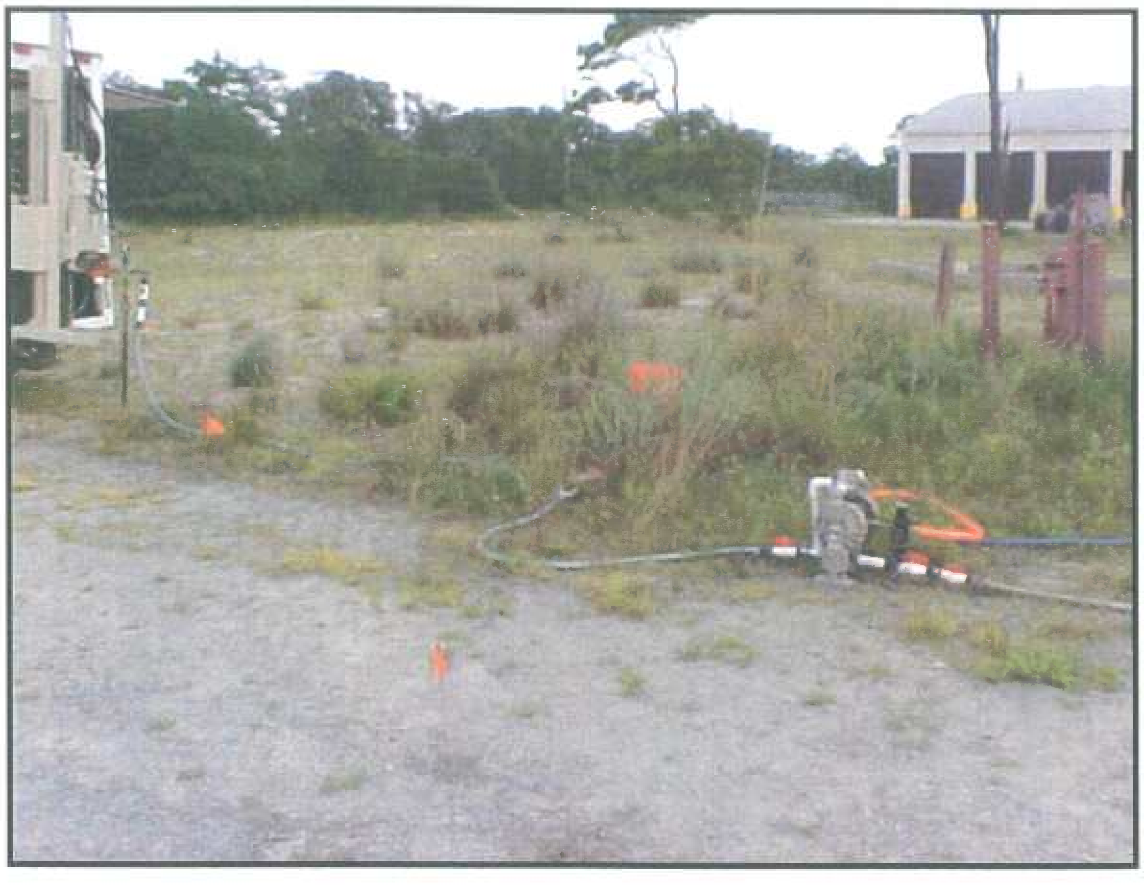
PHOTOGRAPH #3 – PERMANGANATE DRUM LABEL



PHOTOGRAPH #4 – INJECTION POINT INSTALLATION WITH GEOPROBE

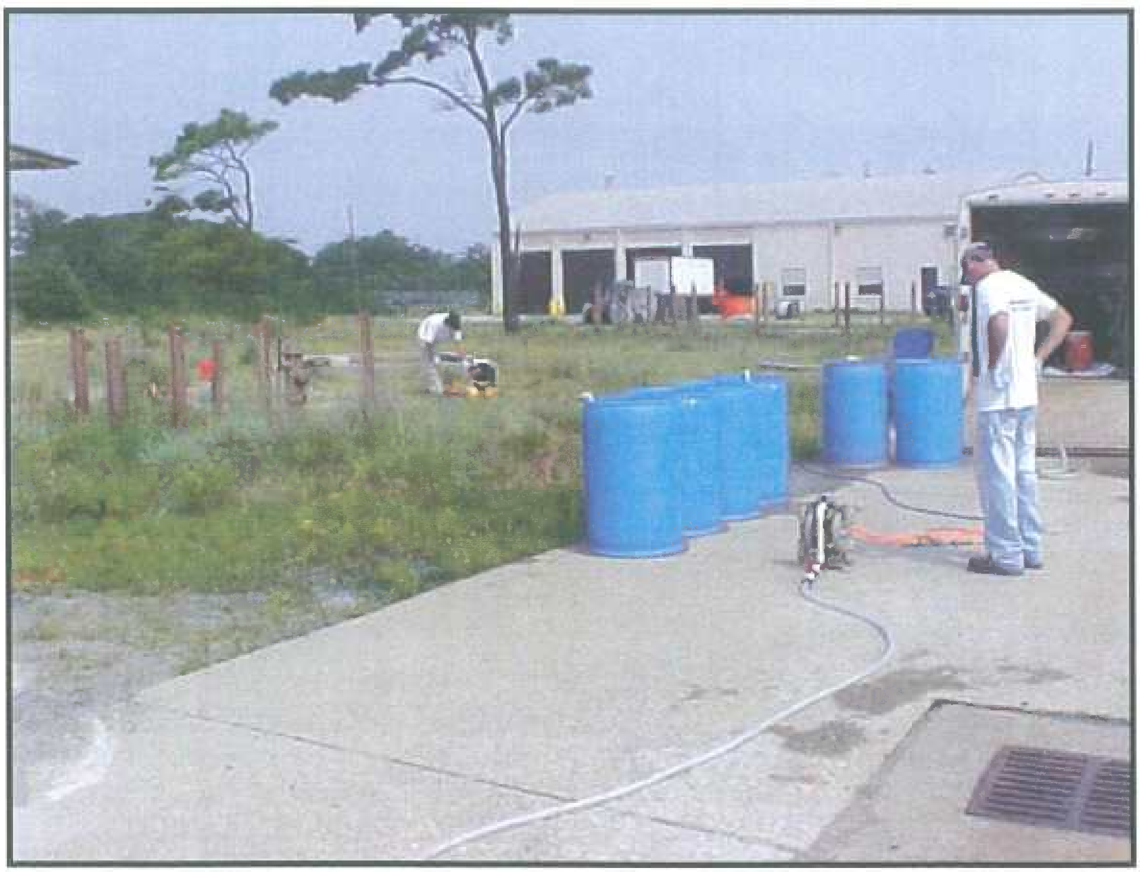


PHOTOGRAPH #5 – PERMANGANATE PUMPLING



PHOTOGRAPH #6 – PERMANGANATE PUMPING

PHOTOGRAPH #7 – PERMANGANATE PUMPING



PHOTOGRAPH #8 – PERMANGANATE PUMPING

GROUNDWATER PILOT STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

PRE-INJECTION #1 ANALYTICAL RESULTS

GROUNDWATER PILOT STUDY REPORT
LARC 60 SITE
FORT STORY, VIRGINIA

U.S. ARMY TRANSPORTATION CENTER
FORT EUSTIS, VIRGINIA

0285-900

ENVIROCOMPLIANCE LABORATORIES, INC.

816 Kiwanis Street
Hampton, Virginia 23661
Phone 804 * 244 * 3424
Fax 804 * 244 * 3243

Certificate of Analysis

Malcolm Pirnie, Inc.
Attn: Grey Richter
701 Town Center Drive
Newport News, VA 23606

Project No. : 0205900
Project Name : Fort Story
Date Received: July 29, 2003
Date Sampled : July 25, 2003
Date Issued : August 07, 2003

Lab # 1/Sample ID : TW-01-GW

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Iron	14.10	mg/l	0.25	07-30/1030	08-06/1400	236.1	PEJ
Chloride	41	mg/l	1	08-01/1127	08-01/1622	300.0	GBH

Lab # 2/Sample ID : MW-117-GW

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Iron	4.60	mg/l	0.25	07-30/1030	08-06/1400	236.1	PEJ
Chloride	16	mg/l	1	08-01/1127	08-01/1622	300.0	GBH

BDL - Below Detection Limit

Anamarie E. McKinley
Laboratory Manager

H3713518-1

Analytical Data Report

Lab Sample ID	Description	Matrix	Date Received	Date Sampled	SDG#
85889-1	TW-01-GW	Liquid	07/30/03	07/25/03 14:00	

Parameter	Units	Lab Sample IDs 85889-1
Volatiles by GC/MS (8260)		
Chloromethane	ug/l	1.0U
Bromomethane (Methyl bromide)	ug/l	1.0U
Vinyl chloride	ug/l	1.0U
Chloroethane	ug/l	1.0U
Methylene chloride (Dichloromethane)	ug/l	5.0U
Acetone	ug/l	25U
Carbon disulfide	ug/l	1.0U
1,1-Dichloroethene	ug/l	1.0U
1,1-Dichloroethane	ug/l	1.0U
Cis/Trans-1,2-Dichloroethene	ug/l	2.0U
Chloroform	ug/l	1.0U
1,2-Dichloroethane	ug/l	1.0U
2-Butanone (MEK)	ug/l	10U
1,1,1-Trichloroethane	ug/l	1.0U
Carbon tetrachloride	ug/l	1.0U
Bromodichloromethane	ug/l	1.0U
1,1,2,2-Tetrachloroethane	ug/l	1.0U
1,2-Dichloropropane	ug/l	1.0U
trans-1,3-Dichloropropene	ug/l	1.0U
Trichloroethene	ug/l	1.0U
Dibromochloromethane	ug/l	1.0U
1,1,2-Trichloroethane	ug/l	1.0U
Benzene	ug/l	1.0U
cis-1,3-Dichloropropene	ug/l	1.0U
Bromoform	ug/l	1.0U
2-Hexanone	ug/l	10U
4-Methyl-2-pentanone (MIBK)	ug/l	10U
Tetrachloroethene	ug/l	1.0U
Toluene	ug/l	1.0U
Chlorobenzene	ug/l	1.0U
Ethylbenzene	ug/l	1.0U
Styrene	ug/l	1.0U
Xylenes, Total	ug/l	2.0U
Surrogate - Toluene-d8 *	%	100 %
Surrogate - 4-Bromofluorobenzene *	%	88 %

Analytical Data Report

Lab Sample ID	Description	Matrix	Date Received	Date Sampled	SDG#
85889-1	TW-01-GW	Liquid	07/30/03	07/25/03 14:00	

Parameter	Units	Lab Sample IDs 85889-1
Volatiles by GC/MS (8260)		
Surrogate - Dibromofluoromethane *	%	100 %
Dilution Factor		1
Prep Date		08/07/03
Analysis Date		08/07/03
Batch ID		1B0807
Total Organic Carbon (415.1)		
Total Organic Carbon	mg/l	3.6
Dilution Factor		1
Prep Date		08/06/03
Analysis Date		08/07/03
Batch ID		0806B
Diesel Range Organics (8015)		
Hydrocarbons as DRO	mg/l	0.10U
Surrogate - o-Terphenyl *	%	63 %
Dilution Factor		1
Prep Date		08/01/03
Analysis Date		08/05/03
Batch ID		0801V
Gasoline Range Organics (8015M)		
Hydrocarbons as GRO	mg/l	0.050U
Surrogate - a,a,a-Trifluorotoluene *	%	57 %
Dilution Factor		1
Prep Date		08/05/03
Analysis Date		08/05/03
Batch ID		1D0805

Analytical Data Report

ab Sample ID	Description	Matrix	Date Received	Date Sampled	SDG#
85889-2	TW-01-SS	Solid	07/30/03	07/25/03 12:45	

Parameter	Units	Lab Sample IDs 85889-2
Volatiles by GC/MS (8260)		
Chloromethane	ug/kg dw	5.9U
Bromomethane (Methyl bromide)	ug/kg dw	5.9U
Vinyl chloride	ug/kg dw	5.9U
Chloroethane	ug/kg dw	5.9U
Methylene chloride (Dichloromethane)	ug/kg dw	5.9U
Acetone	ug/kg dw	59U
Carbon disulfide	ug/kg dw	5.9U
1,1-Dichloroethene	ug/kg dw	5.9U
1,1-Dichloroethane	ug/kg dw	5.9U
Cis/Trans-1,2-Dichloroethene	ug/kg dw	12U
Chloroform	ug/kg dw	5.9U
1,2-Dichloroethane	ug/kg dw	5.9U
2-Butanone (MEK)	ug/kg dw	30U
1,1,1-Trichloroethane	ug/kg dw	5.9U
Carbon tetrachloride	ug/kg dw	5.9U
Bromodichloromethane	ug/kg dw	5.9U
1,1,2,2-Tetrachloroethane	ug/kg dw	5.9U
1,2-Dichloropropane	ug/kg dw	5.9U
trans-1,3-Dichloropropene	ug/kg dw	5.9U
Trichloroethene	ug/kg dw	5.9U
Dibromochloromethane	ug/kg dw	5.9U
1,1,2-Trichloroethane	ug/kg dw	5.9U
Benzene	ug/kg dw	5.9U
cis-1,3-Dichloropropene	ug/kg dw	5.9U
Bromoform	ug/kg dw	5.9U
2-Hexanone	ug/kg dw	30U
4-Methyl-2-pentanone (MIBK)	ug/kg dw	30U
Tetrachloroethene	ug/kg dw	5.9U
Toluene	ug/kg dw	5.9U
Chlorobenzene	ug/kg dw	5.9U
Ethylbenzene	ug/kg dw	5.9U
Styrene	ug/kg dw	5.9U
Xylenes, Total	ug/kg dw	12U
Surrogate - Toluene-d8 *	%	95 %
Surrogate - 4-Bromofluorobenzene *	%	100 %

Analytical Data Report

Lab Sample ID	Description	Matrix	Date Received	Date Sampled	SDG#
85889-2	TW-01-SS	Solid	07/30/03	07/25/03 12:45	

Parameter	Units	Lab Sample IDs 85889-2
Volatiles by GC/MS (8260)		
Surrogate -		
Dibromofluoromethane *	%	108 %
Percent Solids		83
Dilution Factor		1
Prep Date		08/04/03
Analysis Date		08/04/03
Batch ID		1L0804
Total Organic Carbon (9060)		
Total Organic Carbon	mg/kg dw	1000U
Percent Solids		83
Dilution Factor		1
Prep Date		08/04/03
Analysis Date		08/05/03
Batch ID		0805X
Diesel Range Organics (8015)		
Hydrocarbons as DRO	mg/kg dw	4.0U
Surrogate - o-Terphenyl *	%	42 %
Percent Solids		83
Dilution Factor		1
Prep Date		08/05/03
Analysis Date		08/06/03
Batch ID		0805U
Gasoline Range Organics (8015M)		
Hydrocarbons as GRO	mg/kg dw	0.30U
Surrogate -		
a,a,a-Trifluorotoluene *	%	139 %
Percent Solids		83
Dilution Factor		1
Prep Date		08/07/03
Analysis Date		08/07/03
Batch ID		1A0807

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

GW-MW-117

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: Q2849

Matrix: (soil/water) WATER Lab Sample ID: Q2849-3

Sample wt/vol: 5 (g/ml) ML Lab File ID: Q2849-3B59

Level: (low/med) LOW Date Received: 01/15/03

% Moisture: not dec. ________ Date Analyzed: 01/22/03

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	CONCENTRATION	Q
75-71-8	Dichlorodifluoromethane	5	U
74-87-3	Chloromethane	5	U
75-01-4	Vinyl Chloride	5	U
74-83-9	Bromomethane	5	U
75-00-3	Chloroethane	5	U
75-69-4	Trichlorofluoromethane	5	U
75-35-4	1,1-Dichloroethene	5	U
75-15-0	Carbon disulfide	5	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	5	U
67-64-1	Acetone	32	
75-09-2	Methylene Chloride	5	U
156-60-5	trans-1,2-Dichloroethene	5	U
1634-04-4	Methyl-tert-butyl ether	5	U
75-34-3	1,1-Dichloroethane	5	U
156-59-2	cis-1,2-Dichloroethene	22	
78-93-3	2-butanone	13	U
67-66-3	Chloroform	5	U
71-55-6	1,1,1-Trichloroethane	5	U
56-23-5	Carbon Tetrachloride	5	U
71-43-2	Benzene	5	U
107-06-2	1,2-Dichloroethane	5	U
79-01-6	Trichloroethene	1	J
78-87-5	1,2-Dichloropropane	5	U
75-27-4	Bromodichloromethane	5	U
10061-01-5	cis-1,3-Dichloropropene	5	U
108-10-1	4-Methyl-2-pentanone	13	U
108-88-3	Toluene	1	JB
10061-02-6	trans-1,3-Dichloropropene	5	U
79-00-5	1,1,2-Trichloroethane	5	U
127-18-4	Tetrachloroethene	2	J
591-78-6	2-hexanone	13	U
124-48-1	Dibromochloromethane	5	U
106-93-4	1,2-Dibromoethane	5	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

GW-MW-117

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: Q2849

Matrix: (soil/water) WATER   Lab Sample ID: Q2849-3

Sample wt/vol: 5 (g/ml) ML   Lab File ID: Q2849-3B59

Level: (low/med) LOW   Date Received: 01/15/03

% Moisture: not dec. ________   Date Analyzed: 01/22/03

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
108-90-7	Chlorobenzene	5	U
100-41-4	Ethylbenzene	29	
100-42-5	Styrene	5	U
75-25-2	Bromoform	5	U
98-82-8	Isopropyl Benzene	12	
79-34-5	1,1,2,2-Tetrachloroethane	5	U
541-73-1	1,3-Dichlorobenzene	5	U
106-46-7	1,4-Dichlorobenzene	5	U
95-50-1	1,2-Dichlorobenzene	5	U
96-12-8	1,2-Dibromo-3-Chloropropane	5	U
120-82-1	1,2,4-Trichlorobenzene	5	U
1330-20-7	Xylene (total)	130	
79-20-9	Methyl acetate	5	U
110-82-7	Cyclohexane	15	
108-87-2	Methylcyclohexane	26	

FORM I VOA

INJECTION POINT CHLORIDE AND IRON RESULTS
(INJECTIONS #1 AND #2)

GROUNDWATER PILOT STUDY REPORT
LARC 60 SITE
FORT STORY, VIRGINIA

U.S. ARMY TRANSPORTATION CENTER
FORT EUSTIS, VIRGINIA

0285-900

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

INJ-PT1

Name: CompuChem Contract: ______

Lab Code: LIBRTY Case No.: ______ NRAS No.: ______

SDG No.: 525

Matrix (soil/water): WATER Lab Sample ID: 52501

Date Received: 8/18/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	8.18				8/20/03
Ferrous Iron	3.92				8/27/03

Comments:

00002

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

INJ-PT2

Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 525

Matrix (soil/water): WATER Lab Sample ID: 52502

Date Received: 8/18/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	8.48				8/20/03
Ferrous Iron	13.4				8/27/03

Comments:

00003

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

INJ-PT3

Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 525

Matrix (soil/water): WATER Lab Sample ID: 52503

Date Received: 8/18/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	8.28				8/20/03
Ferrous Iron	2.04				8/27/03

Comments:

00004

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

INJ-PT4

Name: CompuChem Contract: ______

Lab Code: LIBRTY Case No.: ______ NRAS No.: ______

SDG No.: 525

Matrix (soil/water): WATER Lab Sample ID: 52504

Date Received: 8/18/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	9.43				8/20/03
Ferrous Iron	1.88				8/27/03

Comments:

00005

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

INJ-PT5

Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 525

Matrix (soil/water): WATER Lab Sample ID: 52505

Date Received: 8/18/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	7.17				8/20/03
Ferrous Iron	1.72				8/27/03

Comments:

Form I - CC

ENVIROCOMPLIANCE LABORATORIES, INC.

816 Kiwanis Street
Hampton, Virginia 23661
Phone 757 · 244 · 3424
Fax 757 · 244 · 3243

Certificate of Analysis

Malcolm Pirnie, Inc.
Attn: Tony Pace
701 Town Center Drive
Newport News, VA 23606

Project No. : 0285-900
Project Name : LARC 60
Date Received: May 14, 2004
Date Sampled : May 14, 2004
Date Issued : May 27, 2004

Lab # 1/Sample ID : IP-1

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Iron	1.84	mg/l	0.25	05-18/0915	05-27/1200	236.1	PEJ
Chloride	12	mg/l	1	05-27/1200	05-27/1215	325.3	PEJ

Lab # 2/Sample ID : IP-2

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Iron	1.05	mg/l	0.25	05-18/0915	05-27/1200	236.1	PEJ
Chloride	9	mg/l	1	05-27/1200	05-27/1215	325.3	PEJ

Lab # 3/Sample ID : IP-3

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Iron	1.10	mg/l	0.25	05-18/0915	05-27/1200	236.1	PEJ
Chloride	14	mg/l	1	05-27/1200	05-27/1215	325.3	PEJ

Lab # 4/Sample ID : IP-4

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Iron	13.77	mg/l	0.25	05-18/0915	05-27/1200	236.1	PEJ
Chloride	16	mg/l	1	05-27/1200	05-27/1215	325.3	PEJ

Lab # 5/Sample ID : IP-5

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Iron	13.25	mg/l	0.25	05-18/0915	05-27/1200	236.1	PEJ
Chloride	19	mg/l	1	05-27/1200	05-27/1215	325.3	PEJ

BDL = Below Detection Limit

Anamarie E. McKinley
Laboratory Manager

H4514924-1

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NEWPORT NEWS
ROUTE:

REBOUND MONITORING – INJECTION #1

GROUNDWATER PILOT STUDY REPORT
LARC 60 SITE
FORT STORY, VIRGINIA

U.S. ARMY TRANSPORTATION CENTER
FORT EUSTIS, VIRGINIA

0285-900

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

MW117-8-22

Lab Name: CompuChem Contract: ______

Lab Code: LIBRTY Case No.: ______ NRAS No.: ______

SDG No.: 677

Matrix (soil/water): WATER Lab Sample ID: 67701

Date Received: 9/3/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	8.99				9/9/03

Comments:

000 2

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

TW-8-26

Lab Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 677

Matrix (soil/water): WATER Lab Sample ID: 67704

Date Received: 9/3/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	34.2				9/9/03

Comments:

Form I - CC

SW846 METALS

-1-

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

MW117-8-22

b Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 677

Matrix (soil/water): WATER Lab Sample ID: 67701

Level (low/med): LOW Date Received: 9/3/03

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7440-38-2	Arsenic	16.3			P
7439-89-6	Iron	6950			P

Color Before: COLORLESS Clarity Before: CLOUDY Texture:

Color After: COLORLESS Clarity After: CLOUDY Artifacts:

Comments:

000 7

SW846 METALS

-1-

INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

TW-8-26

ɔ Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 677

Matrix (soil/water): WATER Lab Sample ID: 67704

Level (low/med): LOW Date Received: 9/3/03

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7440-38-2	Arsenic	2.6	U		P
7439-89-6	Iron	8290			P

Color Before: COLORLESS Clarity Before: CLOUDY Texture:

Color After: COLORLESS Clarity After: CLOUDY Artifacts:

Comments:

000. 9

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

MW117-8-29

Lab Name: CompuChem   Contract:

Lab Code: LIBRTY   Case No.:   NRAS No.:

SDG No.: 677

Matrix (soil/water): WATER   Lab Sample ID: 67702

Date Received: 9/3/03   % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	11.4				9/9/03

Comments:

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SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

TW-8-29

La ame: CompuChem Contract: ______

Lab Code: LIBRTY Case No.: ______ NRAS No.: ______

SDG No.: 677

Matrix (soil/water): WATER Lab Sample ID: 67703

Date Received: 9/3/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	35.0				9/9/03

Comments:

000 5

SW846 METALS
-1-
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.
MW117-8-29

b Name: COMPUCHEM   Contract: ______

Lab Code: LIBRTY   Case No.: ______   SAS No.: ______   SDG No.: 677

Matrix (soil/water): WATER   Lab Sample ID: 67702

Level (low/med): LOW   Date Received: 9/3/03

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7440-38-2	Arsenic	21.5			P
7439-89-6	Iron	7940			P

Color Before: COLORLESS   Clarity Before: CLOUDY   Texture: ______

Color After: COLORLESS   Clarity After: CLOUDY   Artifacts: ______

Comments:

000 8

SW846 METALS
-1-
INORGANIC ANALYSES DATA SHEET

EPA SAMPLE NO.

TW-8-29

ıb Name: COMPUCHEM Contract:

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 677

Matrix (soil/water): WATER Lab Sample ID: 67703

Level (low/med): LOW Date Received: 9/3/03

% Solids: 0.0

Concentration Units (ug/L or mg/kg dry weight): UG/L

CAS No.	Analyte	Concentration	C	Q	M
7440-38-2	Arsenic	2.6	U		P
7439-89-6	Iron	8160			P

Color Before: COLORLESS Clarity Before: CLOUDY Texture:

Color After: COLORLESS Clarity After: CLOUDY Artifacts:

Comments:

00. 10

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

MW-117-3

Lab Name: CompuChem Contract: ______

Lab Code: LIBRTY Case No.: ______ NRAS No.: ______

SDG No.: 834

Matrix (soil/water): WATER Lab Sample ID: 83401

Date Received: 9/23/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	11.0				10/2/03
Ferrous Iron	6.60				9/30/03

Comments: ______

00 2

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

TW01-3

Lab Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 834

Matrix (soil/water): WATER Lab Sample ID: 83403

Date Received: 9/23/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	34.2				10/2/03
Ferrous Iron	2.38				9/30/03

Comments:

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SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

MW-117-4

Lab Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 834

Matrix (soil/water): WATER Lab Sample ID: 83402

Date Received: 9/23/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	9.84				10/2/03
Ferrous Iron	1.90				9/30/03

Comments:

00 3

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

TW01-4

Lab Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 834

Matrix (soil/water): WATER Lab Sample ID: 83404

Date Received: 9/23/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	35.7				10/2/03
Ferrous Iron	2.48				9/30/03

Comments:

000 5

Form I - CC

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

MW-117-5

Lab Name: CompuChem Contract: ______

Lab Code: LIBRTY Case No.: ______ NRAS No.: ______

SDG No.: 862

Matrix (soil/water): WATER Lab Sample ID: 86201

Date Received: 9/25/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	9.46				10/2/03
Ferrous Iron	3.80				9/30/03

Comments:

2

Form I - CC

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

TW-01-5

Lab Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 862

Matrix (soil/water): WATER Lab Sample ID: 86202

Date Received: 9/25/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	34.7				10/2/03
Ferrous Iron	5.45				9/30/03

Comments:

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Form I - CC

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

MW117

Lab Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 1142

Matrix (soil/water): WATER Lab Sample ID: 114202

Date Received: 10/20/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	11.7				10/21/03
TOC	27.91				10/24/03
Ferrous Iron	8.25				10/20/03

Comments:

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

TW01

Lab Name: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 1142

Matrix (soil/water): WATER Lab Sample ID: 114201

Date Received: 10/20/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	37.0				10/21/03
TOC	25.43				10/24/03
Ferrous Iron	6.65				10/20/03

Comments:

1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.: MW117

Lab Name: COMPUCHEM   Contract: 8015

Lab Code: COMPU   Case No.:   SAS No.:   SDG No.: 1142

Matrix: (soil/water) WATER   Lab Sample ID: 114202

Sample wt/vol: 1000 (g/mL) ML   Lab File ID: ________

% Moisture: ______ decanted: (Y/N)___   Date Received: 10/20/03

Extraction: (SepF/Cont/Sonc) SEPF   Date Extracted:10/21/03

Concentrated Extract Volume: 2500(uL)   Date Analyzed: 10/22/03

Injection Volume: 1.0(uL)   Dilution Factor: 1.0

GPC Cleanup: (Y/N) N   pH: ___   Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L	Q
9999-99-5	Diesel	2.5	

FORM I PEST

1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.: TW01

Lab Name: COMPUCHEM Contract: 8015

Lab Code: COMPU Case No.: SAS No.: SDG No.: 1142

Matrix: (soil/water) WATER Lab Sample ID: 114201

Sample wt/vol: 1000 (g/mL) ML Lab File ID: ________

% Moisture: ______ decanted: (Y/N)___ Date Received: 10/20/03

Extraction: (SepF/Cont/Sonc) SEPF Date Extracted:10/21/03

Concentrated Extract Volume: 2500(uL) Date Analyzed: 10/22/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/L	Q
9999-99-5	-------Diesel	2.5	U

FORM I PEST

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW117

Lab Name: COMPUCHEM   Method: 8260

.b Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 1142

Matrix: (soil/water) WATER   Lab Sample ID: 114202

Sample wt/vol: 5 (g/ml) ML   Lab File ID: 114202B59

Level: (low/med) LOW   Date Received: 10/20/03

% Moisture: not dec. ________   Date Analyzed: 10/30/03

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	5	U
74-87-3	Chloromethane	5	U
75-01-4	Vinyl Chloride	5	U
74-83-9	Bromomethane	5	U
75-00-3	Chloroethane	5	U
75-69-4	Trichlorofluoromethane	5	U
75-35-4	1,1-Dichloroethene	5	U
75-15-0	Carbon disulfide	5	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	5	U
67-64-1	Acetone	13	U
75-09-2	Methylene Chloride	5	U
156-60-5	trans-1,2-Dichloroethene	5	U
1634-04-4	Methyl-tert-butyl ether	5	U
75-34-3	1,1-Dichloroethane	5	U
156-59-2	cis-1,2-Dichloroethene	190	
78-93-3	2-butanone	13	U
67-66-3	Chloroform	5	U
71-55-6	1,1,1-Trichloroethane	5	U
56-23-5	Carbon Tetrachloride	5	U
71-43-2	Benzene	5	U
107-06-2	1,2-Dichloroethane	5	U
79-01-6	Trichloroethene	5	U
78-87-5	1,2-Dichloropropane	5	U
75-27-4	Bromodichloromethane	5	U
10061-01-5	cis-1,3-Dichloropropene	5	U
108-10-1	4-Methyl-2-pentanone	13	U
108-88-3	Toluene	66	
10061-02-6	trans-1,3-Dichloropropene	5	U
79-00-5	1,1,2-Trichloroethane	5	U
127-18-4	Tetrachloroethene	5	U
591-78-6	2-hexanone	13	U
124-48-1	Dibromochloromethane	5	U
106-93-4	1,2-Dibromoethane	5	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW117

Lab Name: COMPUCHEM Method: 8260

.b Code: LIBRTY Case No.: SAS No.: SDG No.: 1142

Matrix: (soil/water) WATER Lab Sample ID: 114202

Sample wt/vol: 5 (g/ml) ML Lab File ID: 114202B59

Level: (low/med) LOW Date Received: 10/20/03

% Moisture: not dec. ________ Date Analyzed: 10/30/03

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
108-90-7	Chlorobenzene	5	U
100-41-4	Ethylbenzene	12	
100-42-5	Styrene	5	U
75-25-2	Bromoform	5	U
98-82-8	Isopropyl Benzene	7	
79-34-5	1,1,2,2-Tetrachloroethane	5	U
541-73-1	1,3-Dichlorobenzene	5	U
106-46-7	1,4-Dichlorobenzene	5	U
95-50-1	1,2-Dichlorobenzene	5	U
96-12-8	1,2-Dibromo-3-Chloropropane	5	U
120-82-1	1,2,4-Trichlorobenzene	5	U
1330-20-7	Xylene (total)	75	
79-20-9	Methyl acetate	5	U
110-82-7	Cyclohexane	5	U
108-87-2	Methylcyclohexane	5	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

TW01

Lab Name: COMPUCHEM Method: 8260

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 1142

Matrix: (soil/water) WATER Lab Sample ID: 114201

Sample wt/vol: 5 (g/ml) ML Lab File ID: 114201B59

Level: (low/med) LOW Date Received: 10/20/03

% Moisture: not dec. ________ Date Analyzed: 10/30/03

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	(ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	5	U
74-87-3	Chloromethane	5	U
75-01-4	Vinyl Chloride	5	U
74-83-9	Bromomethane	5	U
75-00-3	Chloroethane	5	U
75-69-4	Trichlorofluoromethane	5	U
75-35-4	1,1-Dichloroethene	5	U
75-15-0	Carbon disulfide	5	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	5	U
67-64-1	Acetone	13	U
75-09-2	Methylene Chloride	5	U
156-60-5	trans-1,2-Dichloroethene	5	U
1634-04-4	Methyl-tert-butyl ether	5	U
75-34-3	1,1-Dichloroethane	5	U
156-59-2	cis-1,2-Dichloroethene	5	U
78-93-3	2-butanone	13	U
67-66-3	Chloroform	5	U
71-55-6	1,1,1-Trichloroethane	5	U
56-23-5	Carbon Tetrachloride	5	U
71-43-2	Benzene	5	U
107-06-2	1,2-Dichloroethane	5	U
79-01-6	Trichloroethene	5	U
78-87-5	1,2-Dichloropropane	5	U
75-27-4	Bromodichloromethane	5	U
10061-01-5	cis-1,3-Dichloropropene	5	U
108-10-1	4-Methyl-2-pentanone	13	U
108-88-3	Toluene	0.8	J
10061-02-6	trans-1,3-Dichloropropene	5	U
79-00-5	1,1,2-Trichloroethane	5	U
127-18-4	Tetrachloroethene	5	U
591-78-6	2-hexanone	13	U
124-48-1	Dibromochloromethane	5	U
106-93-4	1,2-Dibromoethane	5	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

TW01

Lab Name: COMPUCHEM Method: 8260

b Code: LIBRTY Case No.: SAS No.: SDG No.: 1142

Matrix: (soil/water) WATER Lab Sample ID: 114201

Sample wt/vol: 5 (g/ml) ML Lab File ID: 114201B59

Level: (low/med) LOW Date Received: 10/20/03

% Moisture: not dec. ________ Date Analyzed: 10/30/03

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
108-90-7	Chlorobenzene	5	U
100-41-4	Ethylbenzene	5	U
100-42-5	Styrene	5	U
75-25-2	Bromoform	5	U
98-82-8	Isopropyl Benzene	5	U
79-34-5	1,1,2,2-Tetrachloroethane	5	U
541-73-1	1,3-Dichlorobenzene	5	U
106-46-7	1,4-Dichlorobenzene	5	U
95-50-1	1,2-Dichlorobenzene	5	U
96-12-8	1,2-Dibromo-3-Chloropropane	5	U
120-82-1	1,2,4-Trichlorobenzene	5	U
1330-20-7	Xylene (total)	5	U
79-20-9	Methyl acetate	5	U
110-82-7	Cyclohexane	5	U
108-87-2	Methylcyclohexane	5	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

DP01SS

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 1155

Matrix: (soil/water) SOIL   Lab Sample ID: 115501

Sample wt/vol: 5.0 (g/mL) G   Lab File ID: 15501A71

Level: (low/med) LOW   Date Received: 10/21/03

% Moisture: not dec. 17   Date Analyzed: 10/23/03

GC Column: EQUITY624 ID: 0.53 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
75-71-8	Dichlorodifluoromethane	6	U
74-87-3	Chloromethane	6	U
75-01-4	Vinyl Chloride	6	U
74-83-9	Bromomethane	6	U
75-00-3	Chloroethane	6	U
75-69-4	Trichlorofluoromethane	6	U
75-35-4	1,1-Dichloroethene	6	U
75-15-0	Carbon disulfide	6	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	6	U
67-64-1	Acetone	15	U
75-09-2	Methylene Chloride	6	U
156-60-5	trans-1,2-Dichloroethene	6	U
1634-04-4	Methyl-tert-butyl ether	6	U
75-34-3	1,1-Dichloroethane	6	U
156-59-2	cis-1,2-Dichloroethene	6	U
78-93-3	2-butanone	15	U
67-66-3	Chloroform	6	U
71-55-6	1,1,1-Trichloroethane	6	U
56-23-5	Carbon Tetrachloride	6	U
71-43-2	Benzene	6	U
107-06-2	1,2-Dichloroethane	6	U
79-01-6	Trichloroethene	6	U
78-87-5	1,2-Dichloropropane	6	U
75-27-4	Bromodichloromethane	6	U
10061-01-5	cis-1,3-Dichloropropene	6	U
108-10-1	4-Methyl-2-pentanone	15	U
108-88-3	Toluene	6	U
10061-02-6	trans-1,3-Dichloropropene	6	U
79-00-5	1,1,2-Trichloroethane	6	U
127-18-4	Tetrachloroethene	6	U
591-78-6	2-hexanone	15	U
124-48-1	Dibromochloromethane	6	U
106-93-4	1,2-Dibromoethane	6	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

DP01SS

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 1155

Matrix: (soil/water) SOIL   Lab Sample ID: 115501

Sample wt/vol: 5.0 (g/mL) G   Lab File ID: 15501A71

Level: (low/med) LOW   Date Received: 10/21/03

% Moisture: not dec. 17   Date Analyzed: 10/23/03

GC Column: EQUITY624 ID: 0.53 (mm)   Dilution Factor: 1.0

Soil Extract Volume:_________(uL)   Soil Aliquot Volume: _________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-90-7	Chlorobenzene	6	U
100-41-4	Ethylbenzene	6	U
100-42-5	Styrene	6	U
75-25-2	Bromoform	6	U
98-82-8	Isopropyl Benzene	6	U
79-34-5	1,1,2,2-Tetrachloroethane	6	U
541-73-1	1,3-Dichlorobenzene	6	U
106-46-7	1,4-Dichlorobenzene	6	U
95-50-1	1,2-Dichlorobenzene	6	U
96-12-8	1,2-Dibromo-3-Chloropropane	6	U
120-82-1	1,2,4-Trichlorobenzene	6	U
1330-20-7	Xylene (total)	5	J
79-20-9	Methyl acetate	6	U
110-82-7	Cyclohexane	6	U
108-87-2	Methylcyclohexane	6	U

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

DP01SS

La ame: CompuChem   Contract: ______

Lab Code: LIBRTY   Case No.: ______   NRAS No.: ______

SDG No.: 1155

Matrix (soil/water): SOIL   Lab Sample ID: 115501

Date Received: 10/21/03   % Solids: 82.60

Concentration Units (mg/L or mg/kg dry weight): mg/Kg

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
pH (soil)	9.8				10/24/03
TOC	715.0				10/27/03

Comments: PH is reported in pH units.

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1D
GC EXTRACTABLE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.

DP01SS

Lab Name: COMPUCHEM Contract: 8015

Lab Code: COMPU Case No.: SAS No.: SDG No.: 1155

Matrix: (soil/water) SOIL Lab Sample ID: 115501

Sample wt/vol: 20.0 (g/mL) G Lab File ID: ________

% Moisture: 17 decanted: (Y/N) N Date Received: 10/21/03

Extraction: (SepF/Cont/Sonc) OTHER Date Extracted:10/23/03

Concentrated Extract Volume: 1000(uL) Date Analyzed: 10/24/03

Injection Volume: 1.0(uL) Dilution Factor: 1.0

GPC Cleanup: (Y/N) N pH: ___ Sulfur Cleanup: (Y/N) N

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) MG/KG	Q
9999-99-5	-------Diesel	12	U

FORM I PEST

SW-846

1-CC

CLASSICAL CHEMISTRY ANALYSES DATA SHEET

EPA SAMPLE NO.

DP01SS

L‹ ame: CompuChem Contract:

Lab Code: LIBRTY Case No.: NRAS No.:

SDG No.: 1157

Matrix (soil/water): WATER Lab Sample ID: 115701

Date Received: 10/21/03 % Solids: 0.00

Concentration Units (mg/L or mg/kg dry weight): mg/L

PARAMETER	CONCENTRATION	C	Q	M	DATE ANALYZED
Chloride	2.17				10/24/03
Ferrous Iron	0.400	U			10/24/03

Comments:

REBOUND MONITORING – INJECTION #2

GROUNDWATER PILOT STUDY REPORT
LARC 60 SITE
FORT STORY, VIRGINIA

MOVING TO PROTECT OUR WORLD

USATC ENVIRONMENTAL

U.S. ARMY TRANSPORTATION CENTER
FORT EUSTIS, VIRGINIA

0285-900

ENVIROCOMPLIANCE LABORATORIES, INC.
816 Kiwanis Street
Hampton, Virginia 23661
Phone 757 · 244 · 3424
Fax 757 · 244 · 3243

Certificate of Analysis

Malcolm Pirnie, Inc.
Attn: Tony Pace
701 Town Center Drive
Newport News, VA 23606

Project No. : 2118-035
Project Name : LARC 60
Date Received: May 28, 2004
Date Sampled : May 28, 2004
Date Issued : June 24, 2004

Lab # 1/Sample ID : MW-117

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Chloride	205	mg/l	1	06-21/1300	06-21/1645	300.0	SGM
Iron	6.5	mg/l	0.2	06-04/0915	06-09/1425	236.1	JFJ

Lab # 2/Sample ID : Temp Well

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Chloride	116	mg/l	1	06-21/1300	06-21/1645	300.0	SGM
Iron	4.7	mg/l	0.2	06-04/0915	06-09/1425	236.1	JFJ

BDL = Below Detection Limit

Anamarie E. McKinley
Laboratory Manager

H4514992-1

ENVIROCOMPLIANCE LABORATORIES, INC.

816 Kiwanis Street
Hampton, Virginia 23661
Phone 757 · 244 · 3424
Fax 757 · 244 · 3243

Certificate of Analysis

Malcolm Pirnie, Inc.
Attn: Tony Pace
701 Town Center Drive
Newport News, VA 23606

Project Name : LARC 60 - FT. Story
Date Received: June 07, 2004
Date Sampled : June 07, 2004
Date Issued : June 24, 2004

Lab # 1/Sample ID : MW-117

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Chloride	124	mg/l	1	06-21/1300	06-21/1645	300.0	SGM
Iron	5.7	mg/l	0.2	06-04/0915	06-09/1425	236.1	JFJ

Lab # 2/Sample ID : Temporary Well

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Chloride	396	mg/l	1	06-21/1300	06-21/1645	300.0	SGM
Iron	6.1	mg/l	0.2	06-04/0915	06-09/1425	236.1	JFJ

BDL = Below Detection Limit

Anamarie E. McKinley
Laboratory Manager

H4615028-1

ENVIROCOMPLIANCE LABORATORIES, INC.

816 Kiwanis Street
Hampton, Virginia 23661
Phone 757 - 244 - 3424
Fax 757 - 244 - 3243

Certificate of Analysis

Malcolm Pirnie, Inc.
Attn: Tony Pace
701 Town Center Drive
Newport News, VA 23606

Project No. : 2118-035
Project Name : LARC 60 - FT. Story
Date Received: June 15, 2004
Date Sampled : June 14, 2004
Date Issued : July 06, 2004

Lab # 1/Sample ID : MW-117

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Chloride	107	mg/l	1	07-02/1545	07-02/1700	SM4500CL	SGM
Iron	4.8	mg/l	1.0	06-16/0830	06-16/1630	236.1	JFJ

Lab # 2/Sample ID : Temporary Well

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Chloride	45	mg/l	1	07-02/1545	07-02/1700	SM4500CL	SGM
[illegible]n	6.4	mg/l	1.0	06-16/0830	06-16/1630	236.1	JFJ

BDL = Below Detection Limit

Anamarie E. McKinley
Laboratory Manager

H4615066-1

ENVIROCOMPLIANCE LABORATORIES, INC.

816 Kiwanis Street
Hampton, Virginia 23661
Phone 757 · 244 · 3424
Fax 757 · 244 · 3243

Certificate of Analysis

Malcolm Pirnie, Inc.
Attn: Tony Pace
701 Town Center Drive
Newport News, VA 23606

Project No. : 2118-035
Project Name : LARC 60
Date Received: June 18, 2004
Date Sampled : June 18, 2004
Date Issued : July 06, 2004

Lab # 1/Sample ID : MW-117

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Iron	5.9	mg/l	1.0	06-21/1030	06-22/0900	236.1	JFJ
Chloride	12	mg/l	1	07-02/1545	07-02/1700	SM4500CL	SGM

Lab # 2/Sample ID : Temporary Well

Parameter	Result	Units	DL	Date/Time Prepared	Date/Time Analyzed	Method	Analyst
Iron	7.3	mg/l	1.0	06-21/1030	06-22/0900	236.1	JFJ
hloride	351	mg/l	1	07-02/1545	07-02/1700	SM4500CL	SGM

BDL = Below Detection Limit

Anamarie E. McKinley
Laboratory Manager

515100-1

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-117

Lab Name: COMPUCHEM   Method: 8260B

Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357605

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357605B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.50	U
156-60-5	trans-1,2-Dichloroethene	0.25	J
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	24	
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	4.0	
108-88-3	Toluene	0.15	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.67	
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-117

Lab Name: COMPUCHEM Method: 8260B

Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357605

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357605B62

Level: (low/med) LOW Date Received: 07/01/04

% Moisture: not dec. ________ Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	6.8	
108-38-3	m,p-Xylene	29	
95-47-6	o-Xylene	32	E
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	6.2	
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	65	
110-82-7	Cyclohexane	2.7	
108-87-2	Methylcyclohexane	16	

2004 SITE-WIDE GROUNDWATER MONITORING RESULTS

GROUNDWATER PILOT STUDY REPORT
LARC 60 SITE
FORT STORY, VIRGINIA

U.S. ARMY TRANSPORTATION CENTER
FORT EUSTIS, VIRGINIA

0285-900

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-117

ᵀ ъ Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357605

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357605B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.50	U
156-60-5	trans-1,2-Dichloroethene	0.25	J
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	24	
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	4.0	
108-88-3	Toluene	0.15	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.67	
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.: MW-117

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357605

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357605B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS   ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	6.8	
108-38-3	m,p-Xylene	29	
95-47-6	o-Xylene	32	E
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	6.2	
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	65	
110-82-7	Cyclohexane	2.7	
108-87-2	Methylcyclohexane	16	

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

MW-117

Lab Name: COMPUCHEM   Contract: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357605

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357605B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

Number TICs found: 10

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1. 620-14-4	BENZENE, 1-ETHYL-3-METHYL-	6.52	4.9	NJ
2. 108-67-8	BENZENE, 1,3,5-TRIMETHYL-	6.56	3.3	NJ
3. 611-14-3	BENZENE, 1-ETHYL-2-METHYL-	6.65	3.9	NJ
4. 108-67-8	BENZENE, 1,3,5-TRIMETHYL-	6.71	9.9	NJ
5.	SUBSTITUTED BENZENE	6.94	4.2	J
6. 1758-88-9	BENZENE, 2-ETHYL-1,4-DIMETHY	6.96	2.5	NJ
7. 99-87-6	BENZENE, 1-METHYL-4-(1-METHY	7.08	2.5	NJ
8. 767-58-8	INDAN, 1-METHYL-	7.16	2.0	NJ
9. 95-93-2	BENZENE, 1,2,4,5-TETRAMETHYL	7.29	2.0	NJ
10. 768-00-3	BENZENE, (1-METHYL-1-PROPENY	7.45	3.9	NJ
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-117DL

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357605

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357605DB62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.9

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	UG/L	Q
75-71-8	Dichlorodifluoromethane	0.96	U
74-87-3	Chloromethane	0.96	U
75-01-4	Vinyl Chloride	0.96	U
74-83-9	Bromomethane	0.96	U
75-00-3	Chloroethane	0.96	U
75-69-4	Trichlorofluoromethane	0.96	U
75-35-4	1,1-Dichloroethene	0.96	U
75-15-0	Carbon disulfide	0.96	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.96	U
67-64-1	Acetone	71	D
79-20-9	Methyl acetate	0.96	U
75-09-2	Methylene Chloride	0.43	DJ
156-60-5	trans-1,2-Dichloroethene	0.24	DJ
1634-04-4	Methyl-tert-butyl ether	0.96	U
75-34-3	1,1-Dichloroethane	0.96	U
156-59-2	cis-1,2-Dichloroethene	23	D
78-93-3	2-butanone	4.8	U
67-66-3	Chloroform	0.96	U
71-55-6	1,1,1-Trichloroethane	0.96	U
56-23-5	Carbon Tetrachloride	0.96	U
71-43-2	Benzene	0.96	U
107-06-2	1,2-Dichloroethane	0.96	U
79-01-6	Trichloroethene	0.96	U
78-87-5	1,2-Dichloropropane	0.96	U
75-27-4	Bromodichloromethane	0.96	U
10061-01-5	cis-1,3-Dichloropropene	0.96	U
108-10-1	4-Methyl-2-pentanone	4.8	U
108-88-3	Toluene	0.96	U
10061-02-6	trans-1,3-Dichloropropene	0.96	U
79-00-5	1,1,2-Trichloroethane	0.96	U
127-18-4	Tetrachloroethene	0.61	DJ
591-78-6	2-hexanone	4.8	U
124-48-1	Dibromochloromethane	0.96	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-117DL

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357605

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357605DB62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.9

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	CONCENTRATION	Q
106-93-4	1,2-Dibromoethane	0.96	U
108-90-7	Chlorobenzene	0.96	U
100-41-4	Ethylbenzene	6.0	D
108-38-3	m,p-Xylene	25	D
95-47-6	o-Xylene	29	D
100-42-5	Styrene	0.96	U
75-25-2	Bromoform	0.96	U
98-82-8	Isopropyl Benzene	5.4	D
79-34-5	1,1,2,2-Tetrachloroethane	0.96	U
541-73-1	1,3-Dichlorobenzene	0.96	U
106-46-7	1,4-Dichlorobenzene	0.96	U
95-50-1	1,2-Dichlorobenzene	0.96	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.96	U
120-82-1	1,2,4-Trichlorobenzene	0.96	U
1330-20-7	Xylene (total)	57	D
110-82-7	Cyclohexane	2.6	D
108-87-2	Methylcyclohexane	14	D

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

MW-117DL

Lab Name: COMPUCHEM Contract: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357605

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357605DB62

Level: (low/med) LOW Date Received: 07/01/04

% Moisture: not dec. ________ Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.9

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

Number TICs found: 10

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1. 620-14-4	BENZENE, 1-ETHYL-3-METHYL-	6.57	9.2	NJD
2. 108-67-8	BENZENE, 1,3,5-TRIMETHYL-	6.60	6.2	NJD
3. 611-14-3	BENZENE, 1-ETHYL-2-METHYL-	6.69	7.3	NJD
4. 526-73-8	BENZENE, 1,2,3-TRIMETHYL-	6.76	20	NJD
5.	SUBSTITUTED BENZENE	6.98	12	JD
6. 95-93-2	BENZENE, 1,2,4,5-TETRAMETHYL	7.12	5.1	NJD
7. 2870-04-4	BENZENE, 2-ETHYL-1,3-DIMETHY	7.14	3.6	NJD
8. 768-49-0	BENZENE, (2-METHYL-1-PROPENY	7.19	4.1	NJD
9. 95-93-2	BENZENE, 1,2,4,5-TETRAMETHYL	7.32	4.5	NJD
10. 768-00-3	BENZENE, (1-METHYL-1-PROPENY	7.49	7.7	NJD
11.				
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-118

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362904

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362904RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.26	J
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.12	J
67-64-1	Acetone	3.0	
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.43	JB
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	1.5	J
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.27	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-118

Lab Name: COMPUCHEM   Method: 8260B

ab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362904

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362904RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

MW-118

Lab Name: COMPUCHEM Contract: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 362904

Sample wt/vol: 25 (g/ml) ML Lab File ID: 362904RB71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ______ Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: ______ (uL) Soil Aliquot Volume: ______ (uL

Number TICs found: 5

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	11.80	0.92	JB
2.	LABORATORY ARTIFACT	12.98	1.1	JB
3.	STRAIGHT-CHAIN ALKANE	13.54	1.2	JB
4.	LABORATORY ARTIFACT	14.18	0.88	JB
5. 112-95-8	EICOSANE	15.04	0.60	NJ
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-2

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 362903

Sample wt/vol: 25 (g/ml) ML Lab File ID: 362903A71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.23	JB
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.83	
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	260	E
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.52	B
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	21	
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.29	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-2

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362903

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362903A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-2

Lab Name: COMPUCHEM Contract: 8260B

ab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 362903

Sample wt/vol: 25 (g/ml) ML Lab File ID: 362903A71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

Number TICs found: 4

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	10.23	0.77	J
2.	LABORATORY ARTIFACT	11.81	0.77	J
3.	LABORATORY ARTIFACT	12.99	1.1	J
4.	LABORATORY ARTIFACT	14.19	0.89	J
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.: 6MW-2DL

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362903

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362903D2A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 3.1

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	CONCENTRATION (UG/L)	Q
75-71-8	Dichlorodifluoromethane	1.6	U
74-87-3	Chloromethane	0.50	DJ
75-01-4	Vinyl Chloride	1.6	U
74-83-9	Bromomethane	1.6	U
75-00-3	Chloroethane	1.6	U
75-69-4	Trichlorofluoromethane	1.6	U
75-35-4	1,1-Dichloroethene	1.6	U
75-15-0	Carbon disulfide	1.5	DJ
76-13-1	1,1,2-trichloro-1,2,2-triflu	1.6	U
67-64-1	Acetone	270	D
79-20-9	Methyl acetate	1.6	U
75-09-2	Methylene Chloride	1.2	DJB
156-60-5	trans-1,2-Dichloroethene	1.6	U
1634-04-4	Methyl-tert-butyl ether	1.6	U
75-34-3	1,1-Dichloroethane	1.6	U
156-59-2	cis-1,2-Dichloroethene	1.6	U
78-93-3	2-butanone	21	D
67-66-3	Chloroform	1.6	U
71-55-6	1,1,1-Trichloroethane	1.6	U
56-23-5	Carbon Tetrachloride	1.6	U
71-43-2	Benzene	1.6	U
107-06-2	1,2-Dichloroethane	1.6	U
79-01-6	Trichloroethene	1.6	U
78-87-5	1,2-Dichloropropane	1.6	U
75-27-4	Bromodichloromethane	1.6	U
10061-01-5	cis-1,3-Dichloropropene	1.6	U
108-10-1	4-Methyl-2-pentanone	7.8	U
108-88-3	Toluene	0.54	DJ
10061-02-6	trans-1,3-Dichloropropene	1.6	U
79-00-5	1,1,2-Trichloroethane	1.6	U
127-18-4	Tetrachloroethene	1.6	U
591-78-6	2-hexanone	7.8	U
124-48-1	Dibromochloromethane	1.6	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-2DL

Lab Name: COMPUCHEM   Method: 8260B

ab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362903

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362903D2A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 3.1

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	1.6	U
108-90-7	Chlorobenzene	1.6	U
100-41-4	Ethylbenzene	1.6	U
108-38-3	m,p-Xylene	3.1	U
95-47-6	o-Xylene	1.6	U
100-42-5	Styrene	1.6	U
75-25-2	Bromoform	1.6	U
98-82-8	Isopropyl Benzene	1.6	U
79-34-5	1,1,2,2-Tetrachloroethane	1.6	U
541-73-1	1,3-Dichlorobenzene	1.6	U
106-46-7	1,4-Dichlorobenzene	1.6	U
95-50-1	1,2-Dichlorobenzene	1.6	U
96-12-8	1,2-Dibromo-3-Chloropropane	1.6	U
120-82-1	1,2,4-Trichlorobenzene	1.6	U
1330-20-7	Xylene (total)	1.6	U
110-82-7	Cyclohexane	1.6	U
108-87-2	Methylcyclohexane	1.6	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-2DL

Lab Name: COMPUCHEM   Contract: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362903

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362903D2A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ______   Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 3.1

Soil Extract Volume:______(uL)   Soil Aliquot Volume: ______(uL

Number TICs found: 6

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	10.11	5.9	JBD
2.	LABORATORY ARTIFACT	11.80	3.1	JBD
3.	LABORATORY ARTIFACT	12.98	5.0	JBD
4.	STRAIGHT-CHAIN ALKANE	13.55	3.5	JBD
5.	LABORATORY ARTIFACT	14.19	2.6	JBD
6.	STRAIGHT-CHAIN ALKANE	15.04	1.7	JBD
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-3S

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362905

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362905DB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 8.3

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	UG/L	Q
75-71-8	Dichlorodifluoromethane	4.2	U
74-87-3	Chloromethane	0.84	J
75-01-4	Vinyl Chloride	9.7	
74-83-9	Bromomethane	4.2	U
75-00-3	Chloroethane	4.2	U
75-69-4	Trichlorofluoromethane	4.2	U
75-35-4	1,1-Dichloroethene	1.3	J
75-15-0	Carbon disulfide	4.2	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	4.2	U
67-64-1	Acetone	17	J
79-20-9	Methyl acetate	4.2	U
75-09-2	Methylene Chloride	3.3	JB
156-60-5	trans-1,2-Dichloroethene	0.87	J
1634-04-4	Methyl-tert-butyl ether	4.2	U
75-34-3	1,1-Dichloroethane	4.2	U
156-59-2	cis-1,2-Dichloroethene	100	
78-93-3	2-butanone	21	U
67-66-3	Chloroform	4.2	U
71-55-6	1,1,1-Trichloroethane	4.2	U
56-23-5	Carbon Tetrachloride	4.2	U
71-43-2	Benzene	4.2	U
107-06-2	1,2-Dichloroethane	4.2	U
79-01-6	Trichloroethene	140	
78-87-5	1,2-Dichloropropane	4.2	U
75-27-4	Bromodichloromethane	4.2	U
10061-01-5	cis-1,3-Dichloropropene	4.2	U
108-10-1	4-Methyl-2-pentanone	21	U
108-88-3	Toluene	4.2	U
10061-02-6	trans-1,3-Dichloropropene	4.2	U
79-00-5	1,1,2-Trichloroethane	4.2	U
127-18-4	Tetrachloroethene	62	
591-78-6	2-hexanone	21	U
124-48-1	Dibromochloromethane	4.2	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-3S

Lab Name: COMPUCHEM   Method: 8260B

ıb Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362905

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362905DB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 8.3

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	4.2	U
108-90-7	Chlorobenzene	4.2	U
100-41-4	Ethylbenzene	4.2	U
108-38-3	m,p-Xylene	8.3	U
95-47-6	o-Xylene	4.2	U
100-42-5	Styrene	4.2	U
75-25-2	Bromoform	4.2	U
98-82-8	Isopropyl Benzene	4.2	U
79-34-5	1,1,2,2-Tetrachloroethane	4.2	U
541-73-1	1,3-Dichlorobenzene	4.2	U
106-46-7	1,4-Dichlorobenzene	4.2	U
95-50-1	1,2-Dichlorobenzene	4.2	U
96-12-8	1,2-Dibromo-3-Chloropropane	4.2	U
120-82-1	1,2,4-Trichlorobenzene	4.2	U
1330-20-7	Xylene (total)	4.2	U
110-82-7	Cyclohexane	4.2	U
108-87-2	Methylcyclohexane	4.2	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-3S

Lab Name: COMPUCHEM   Contract: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362905

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362905DB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 8.3

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

Number TICs found: 6

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	10.11	15	J
2.	LABORATORY ARTIFACT	11.80	8.6	JB
3.	LABORATORY ARTIFACT	12.98	13	JB
4.	STRAIGHT-CHAIN ALKANE	13.54	8.9	JB
5.	LABORATORY ARTIFACT	14.18	20	JB
6.	STRAIGHT-CHAIN ALKANE	15.04	15	JB
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.: 6MW-3D

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362906

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362906RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.21	J
75-01-4	Vinyl Chloride	0.20	J
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	3.3	
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.47	JB
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.33	J
78-93-3	2-butanone	2.5	
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.42	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-3D

Lab Name: COMPUCHEM Method: 8260B

ab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 362906

Sample wt/vol: 25 (g/ml) ML Lab File ID: 362906RB71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-3D

Lab Name: COMPUCHEM Contract: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 362906

Sample wt/vol: 25 (g/ml) ML Lab File ID: 362906RB71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

Number TICs found: 5

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	UNKNOWN	5.69	0.56	J
2.	LABORATORY ARTIFACT	11.80	0.83	JB
3.	LABORATORY ARTIFACT	12.98	0.87	JB
4.	STRAIGHT-CHAIN ALKANE	13.55	0.87	JB
5.	LABORATORY ARTIFACT	14.19	0.59	JB
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-5S

b Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357603

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357603B61

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	(ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.18	J
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	1.1	
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	1.7	
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.50	U
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.84	
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-5S

b Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357603

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357603B61

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-5S

Lab Name: COMPUCHEM Contract: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357603

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357603B61

Level: (low/med) LOW Date Received: 07/01/04

% Moisture: not dec. ________ Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-5D

b Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357606

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357606RB62

Level: (low/med) LOW   Date Received: 07/02/04

% Moisture: not dec. ________   Date Analyzed: 07/14/04

GC Column: RTX-VMS   ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.50	U
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.10	JB
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.50	U
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-5D

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357606

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357606RB62

Level: (low/med) LOW   Date Received: 07/02/04

% Moisture: not dec. ________   Date Analyzed: 07/14/04

GC Column: RTX-VMS   ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-5D

Lab Name: COMPUCHEM Contract: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357606

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357606RB62

Level: (low/med) LOW Date Received: 07/02/04

% Moisture: not dec. ________ Date Analyzed: 07/14/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

Number TICs found: 0

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-6

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357604

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357604B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.20	J
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.50	U
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-6

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357604

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357604B62

Level: (low/med) LOW Date Received: 07/01/04

% Moisture: not dec. ________ Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-6

Lab Name: COMPUCHEM   Contract: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357604

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357604B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

Number TICs found: 0

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-7

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357601

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357601B62

Level: (low/med) LOW Date Received: 07/01/04

% Moisture: not dec. ________ Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume: ________ (uL) Soil Aliquot Volume: ________ (uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.15	J
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	3.3	
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.83	
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.10	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.49	J
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.12	J

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-7

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357601

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357601B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-7

Lab Name: COMPUCHEM   Contract: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357601

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357601B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

Number TICs found: 0   CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-8

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357602

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357602B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.14	J
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.15	J
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.15	J
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.50	U
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-8

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357602

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357602B62

Level: (low/med) LOW Date Received: 07/01/04

% Moisture: not dec. ________ Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-8

Lab Name: COMPUCHEM   Contract: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357602

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357602B62

Level: (low/med) LOW   Date Received: 07/01/04

% Moisture: not dec. ________   Date Analyzed: 07/13/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.: 6MW-9

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362907

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362907RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.18	J
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	5.4	
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.44	JB
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.15	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-9

Lab Name: COMPUCHEM   Method: 8260B

.b Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362907

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362907RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-9

Lab Name: COMPUCHEM Contract: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 362907

Sample wt/vol: 25 (g/ml) ML Lab File ID: 362907RB71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume: ________ (uL) Soil Aliquot Volume: ________ (uL

Number TICs found: 8

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	10.26	0.57	J
2.	LABORATORY ARTIFACT	11.80	0.78	JB
3.	LABORATORY ARTIFACT	12.98	0.88	JB
4.	STRAIGHT-CHAIN ALKANE	13.54	0.66	JB
5.	LABORATORY ARTIFACT	14.18	0.67	JB
6.	UNKNOWN	14.47	1.0	J
7.	LABORATORY ARTIFACT	15.59	1.1	JB
8. 128-37-0	BUTYLATED HYDROXYTOLUENE	16.98	2.1	NJ
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-10

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362901

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362901RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.31	J
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.22	J
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	5.5	
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.45	JB
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	4.0	
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.36	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-10

Lab Name: COMPUCHEM   Method: 8260B

ab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362901

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362901RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.12	J
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.15	JB
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-10

Lab Name: COMPUCHEM   Contract: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362901

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362901RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

Number TICs found: 5

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	11.80	0.78	JB
2.	LABORATORY ARTIFACT	12.98	0.90	JB
3.	STRAIGHT-CHAIN ALKANE	13.54	0.86	JB
4.	LABORATORY ARTIFACT	14.18	0.59	JB
5.	STRAIGHT-CHAIN ALKANE	15.04	0.68	JB
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-10-DUP

Lab Name: COMPUCHEM Method: 8260B

ab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 362902

Sample wt/vol: 25 (g/ml) ML Lab File ID: 362902RB71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/16/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.18	J
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.22	J
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	3.1	
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.39	JB
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	1.7	J
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.32	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-10-DUP

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362902

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362902RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	CONCENTRATION	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.: 6MW-10-DUP

Lab Name: COMPUCHEM   Contract: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362902

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362902RB71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/16/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

Number TICs found: 4   CONCENTRATION UNITS: (ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	11.80	0.71	JB
2.	LABORATORY ARTIFACT	12.98	0.65	JB
3.	STRAIGHT-CHAIN ALKANE	13.54	0.88	JB
4.	STRAIGHT-CHAIN ALKANE	15.04	0.65	JB
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.: 6MW-11

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357607

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357607RB62

Level: (low/med) LOW Date Received: 07/02/04

% Moisture: not dec. ________ Date Analyzed: 07/14/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.50	U
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.17	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-11

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357607

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357607RB62

Level: (low/med) LOW   Date Received: 07/02/04

% Moisture: not dec. ________   Date Analyzed: 07/14/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.: 6MW-11

Lab Name: COMPUCHEM   Contract: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357607

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357607RB62

Level: (low/med) LOW   Date Received: 07/02/04

% Moisture: not dec. ________   Date Analyzed: 07/14/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-11-DUP

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357608

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357608RB62

Level: (low/med) LOW Date Received: 07/02/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.50	U
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.16	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-11-DUP

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357608

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357608RB62

Level: (low/med) LOW   Date Received: 07/02/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

6MW-11-DUP

Lab Name: COMPUCHEM Contract: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357608

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357608RB62

Level: (low/med) LOW Date Received: 07/02/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

Number TICs found: 0

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-2MS

Lab Name: COMPUCHEM   Method: 8260B

ab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 39798

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 39798A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.17	JB
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	6.4	
75-15-0	Carbon disulfide	0.71	
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	230	E
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.67	B
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	19	
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	5.7	
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	6.3	
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	6.8	
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-2MS

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 39798

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 39798A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	6.4	
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

6MW-2MSD

Lab Name: COMPUCHEM Method: 8260B

ab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 39799

Sample wt/vol: 25 (g/ml) ML Lab File ID: 39799A71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.14	JB
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	6.1	
75-15-0	Carbon disulfide	0.70	
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	220	E
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.57	B
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	18	
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	5.9	
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	6.3	
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	6.5	
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.: 6MW-2MSD

Lab Name: COMPUCHEM Method: 8260B

ab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 39799

Sample wt/vol: 25 (g/ml) ML Lab File ID: 39799A71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	6.3	
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

TRIPBLAN K 070104

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3576

Matrix: (soil/water) WATER   Lab Sample ID: 357609

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 357609RB62

Level: (low/med) LOW   Date Received: 07/02/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: RTX-VMS   ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.54	
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.19	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

TRIPBLAN
K 070104

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357609

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357609RB62

Level: (low/med) LOW Date Received: 07/02/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

TRIPBLAN K 070104

Lab Name: COMPUCHEM Contract: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3576

Matrix: (soil/water) WATER Lab Sample ID: 357609

Sample wt/vol: 25 (g/ml) ML Lab File ID: 357609RB62

Level: (low/med) LOW Date Received: 07/02/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

Number TICs found: 0

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

TRIPBLANK
07-07-04

Lab Name: COMPUCHEM Method: 8260B

.b Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 362908

Sample wt/vol: 25 (g/ml) ML Lab File ID: 362908A71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.18	JB
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.5	U
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.35	JB
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	1.9	J
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.25	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

TRIPBLANK 07-07-04

Lab Name: COMPUCHEM   Method: 8260B

L Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362908

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362908A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	COMPOUND	CONCENTRATION	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.11	J
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.13	J
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.21	J
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.: TRIPBLANK 07-07-04

Lab Name: COMPUCHEM   Contract: 8260B

l Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362908

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362908A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

Number TICs found: 1

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	12.98	0.66	J
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

TRIPBLANK 07-08-04

Lab Name: COMPUCHEM   Method: 8260B

ab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362909

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362909A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.10	JB
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	1.3	J
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.25	JB
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.50	U
156-59-2	cis-1,2-Dichloroethene	0.50	U
78-93-3	2-butanone	1.3	J
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.14	J
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

TRIPBLANK
07-08-04

Lab Name: COMPUCHEM

Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3629

Matrix: (soil/water) WATER   Lab Sample ID: 362909

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 362909A71

Level: (low/med) LOW   Date Received: 07/09/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: ZB-624   ID: 0.32 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.50	U
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.15	J
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT SAMPLE NO.

TRIPBLANK
07-08-04

Lab Name: COMPUCHEM Contract: 8260B

ab Code: LIBRTY Case No.: SAS No.: SDG No.: 3629

Matrix: (soil/water) WATER Lab Sample ID: 362909

Sample wt/vol: 25 (g/ml) ML Lab File ID: 362909A71

Level: (low/med) LOW Date Received: 07/09/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: ZB-624 ID: 0.32 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CONCENTRATION UNITS:
(ug/L or ug/Kg) ug/L

Number TICs found: 3

CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	LABORATORY ARTIFACT	12.99	0.59	J
2.	LABORATORY ARTIFACT	14.18	1.2	J
3.	LABORATORY ARTIFACT	15.60	1.2	J
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FORM I VOA-TIC

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-115

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3654

Matrix: (soil/water) WATER Lab Sample ID: 365401

Sample wt/vol: 25 (g/ml) ML Lab File ID: 365401B62

Level: (low/med) LOW Date Received: 07/14/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	2.9	
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.50	U
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.34	J
156-59-2	cis-1,2-Dichloroethene	0.30	J
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.50	U
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-115

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3654

Matrix: (soil/water) WATER   Lab Sample ID: 365401

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 365401B62

Level: (low/med) LOW   Date Received: 07/14/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: RTX-VMS   ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.16	J
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-115D

Lab Name: COMPUCHEM   Method: 8260B

Lab Code: LIBRTY   Case No.:   SAS No.:   SDG No.: 3654

Matrix: (soil/water) WATER   Lab Sample ID: 365402

Sample wt/vol: 25 (g/ml) ML   Lab File ID: 365402B62

Level: (low/med) LOW   Date Received: 07/14/04

% Moisture: not dec. ________   Date Analyzed: 07/15/04

GC Column: RTX-VMS ID: 0.18 (mm)   Dilution Factor: 1.0

Soil Extract Volume:________(uL)   Soil Aliquot Volume: ________(uL

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
75-71-8	Dichlorodifluoromethane	0.50	U
74-87-3	Chloromethane	0.50	U
75-01-4	Vinyl Chloride	0.50	U
74-83-9	Bromomethane	0.50	U
75-00-3	Chloroethane	0.50	U
75-69-4	Trichlorofluoromethane	0.50	U
75-35-4	1,1-Dichloroethene	0.50	U
75-15-0	Carbon disulfide	0.50	U
76-13-1	1,1,2-trichloro-1,2,2-triflu	0.50	U
67-64-1	Acetone	3.0	
79-20-9	Methyl acetate	0.50	U
75-09-2	Methylene Chloride	0.50	U
156-60-5	trans-1,2-Dichloroethene	0.50	U
1634-04-4	Methyl-tert-butyl ether	0.50	U
75-34-3	1,1-Dichloroethane	0.37	J
156-59-2	cis-1,2-Dichloroethene	0.29	J
78-93-3	2-butanone	2.5	U
67-66-3	Chloroform	0.50	U
71-55-6	1,1,1-Trichloroethane	0.50	U
56-23-5	Carbon Tetrachloride	0.50	U
71-43-2	Benzene	0.50	U
107-06-2	1,2-Dichloroethane	0.50	U
79-01-6	Trichloroethene	0.50	U
78-87-5	1,2-Dichloropropane	0.50	U
75-27-4	Bromodichloromethane	0.50	U
10061-01-5	cis-1,3-Dichloropropene	0.50	U
108-10-1	4-Methyl-2-pentanone	2.5	U
108-88-3	Toluene	0.50	U
10061-02-6	trans-1,3-Dichloropropene	0.50	U
79-00-5	1,1,2-Trichloroethane	0.50	U
127-18-4	Tetrachloroethene	0.50	U
591-78-6	2-hexanone	2.5	U
124-48-1	Dibromochloromethane	0.50	U

FORM I VOA

FORM 1
VOLATILE ORGANICS ANALYSIS DATA SHEET

CLIENT SAMPLE NO.

MW-115D

Lab Name: COMPUCHEM Method: 8260B

Lab Code: LIBRTY Case No.: SAS No.: SDG No.: 3654

Matrix: (soil/water) WATER Lab Sample ID: 365402

Sample wt/vol: 25 (g/ml) ML Lab File ID: 365402B62

Level: (low/med) LOW Date Received: 07/14/04

% Moisture: not dec. ________ Date Analyzed: 07/15/04

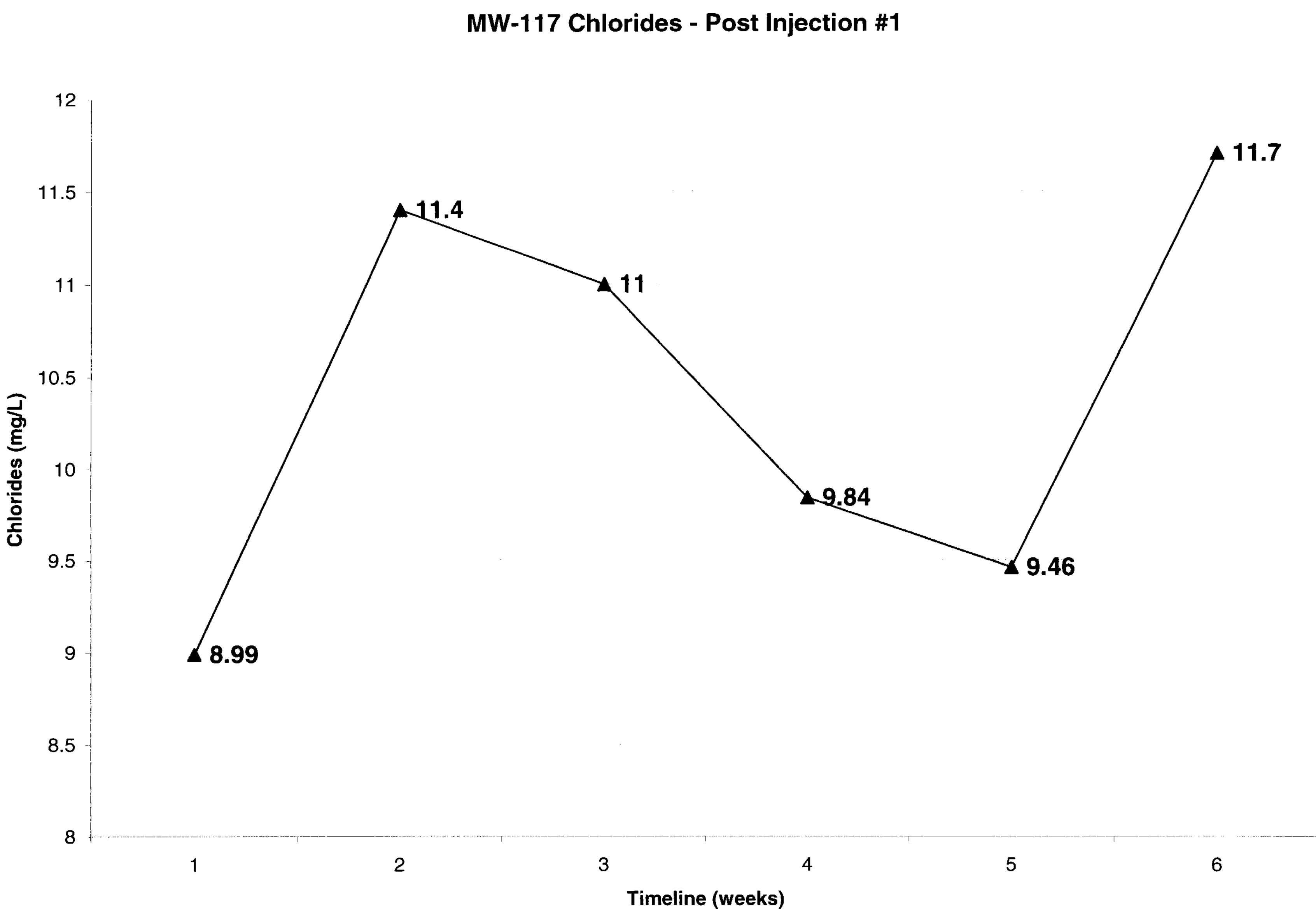
GC Column: RTX-VMS ID: 0.18 (mm) Dilution Factor: 1.0

Soil Extract Volume:________(uL) Soil Aliquot Volume: ________(uL

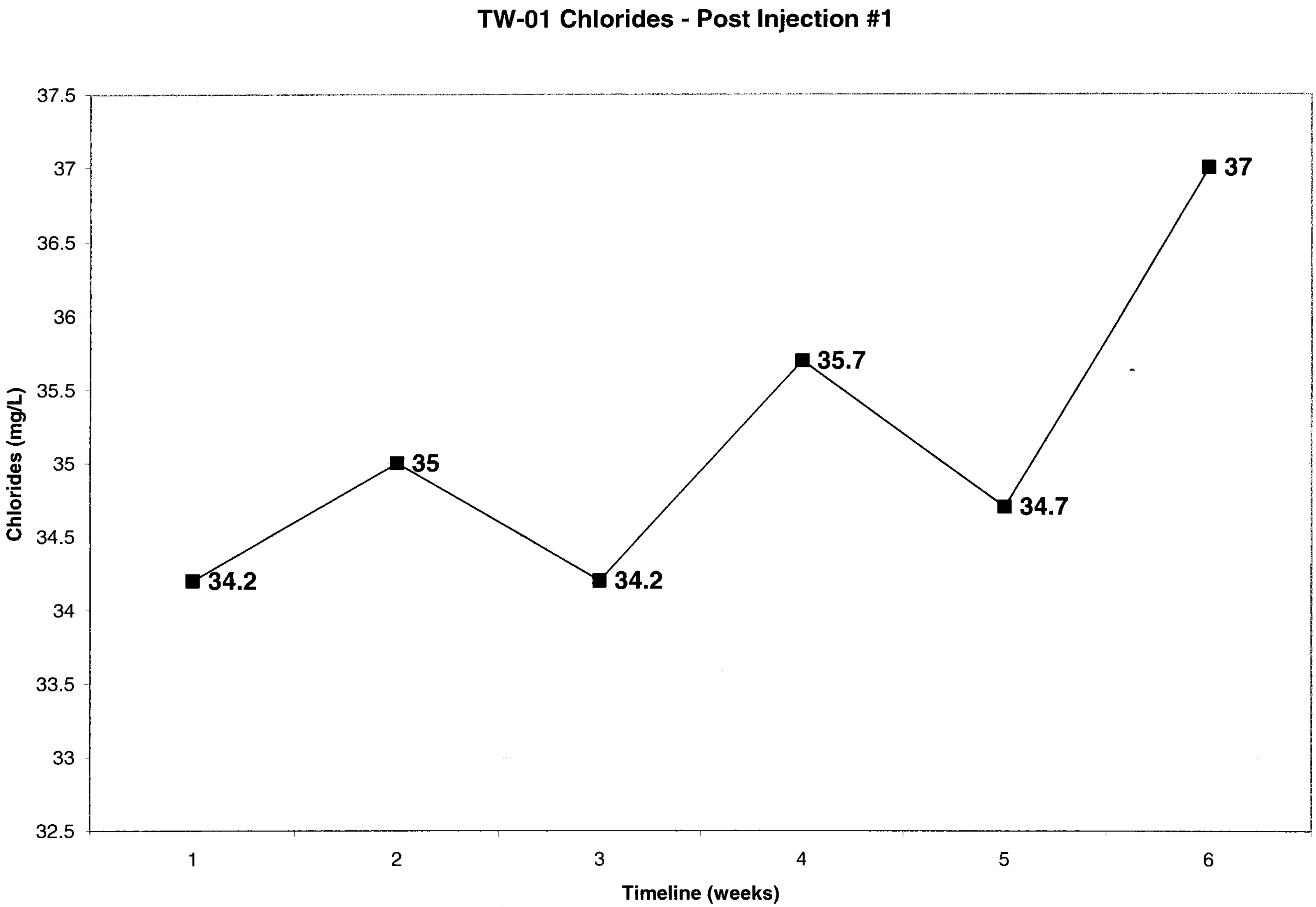
CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

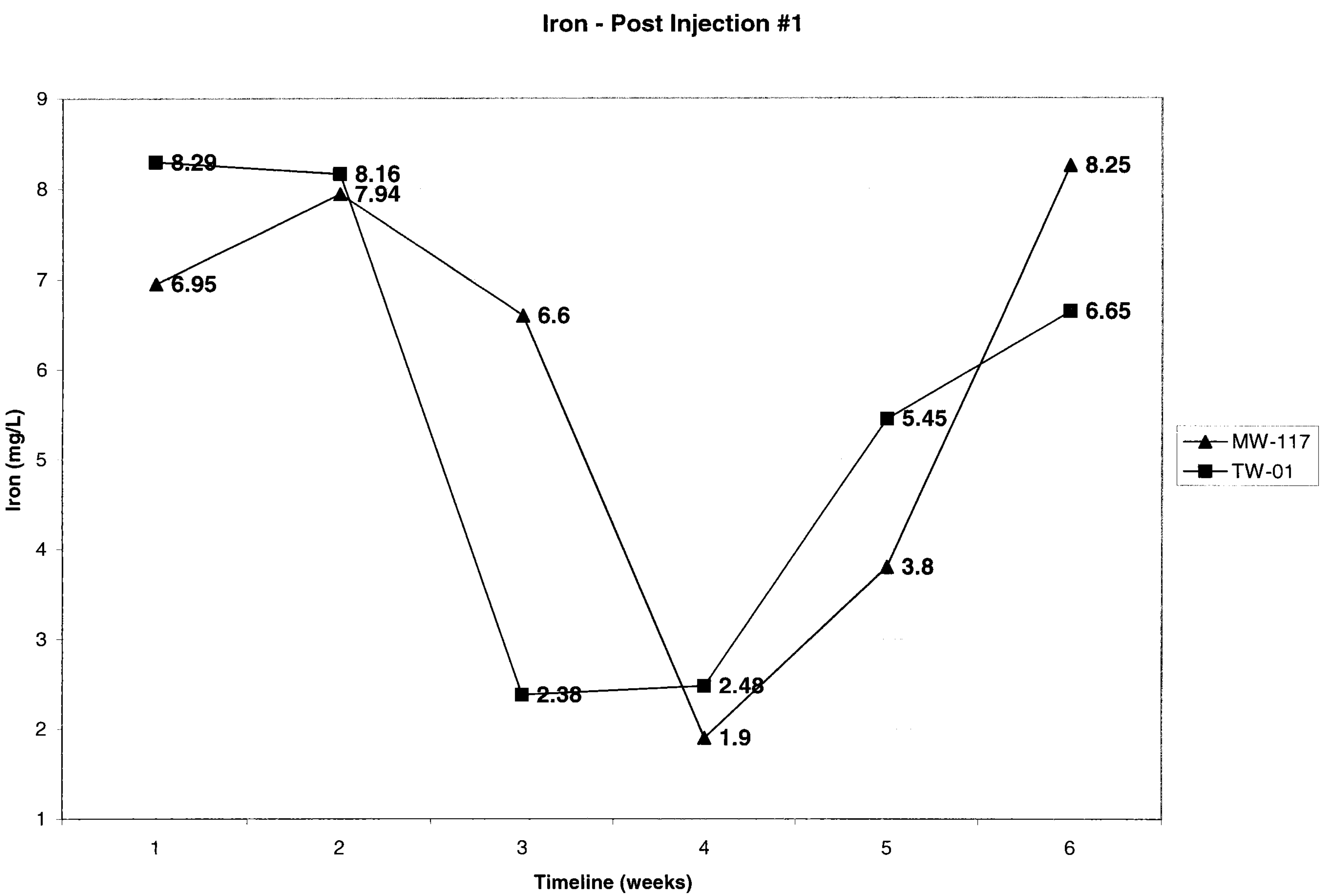
CAS NO.	COMPOUND	UG/L	Q
106-93-4	1,2-Dibromoethane	0.50	U
108-90-7	Chlorobenzene	0.50	U
100-41-4	Ethylbenzene	0.50	U
108-38-3	m,p-Xylene	1.0	U
95-47-6	o-Xylene	0.50	U
100-42-5	Styrene	0.50	U
75-25-2	Bromoform	0.50	U
98-82-8	Isopropyl Benzene	0.50	U
79-34-5	1,1,2,2-Tetrachloroethane	0.50	U
541-73-1	1,3-Dichlorobenzene	0.50	U
106-46-7	1,4-Dichlorobenzene	0.50	U
95-50-1	1,2-Dichlorobenzene	0.17	J
96-12-8	1,2-Dibromo-3-Chloropropane	0.50	U
120-82-1	1,2,4-Trichlorobenzene	0.50	U
1330-20-7	Xylene (total)	0.50	U
110-82-7	Cyclohexane	0.50	U
108-87-2	Methylcyclohexane	0.50	U

GROUNDWATER PILOT STUDY
LARC 60 SITE
FORT STORY, VIRGINIA

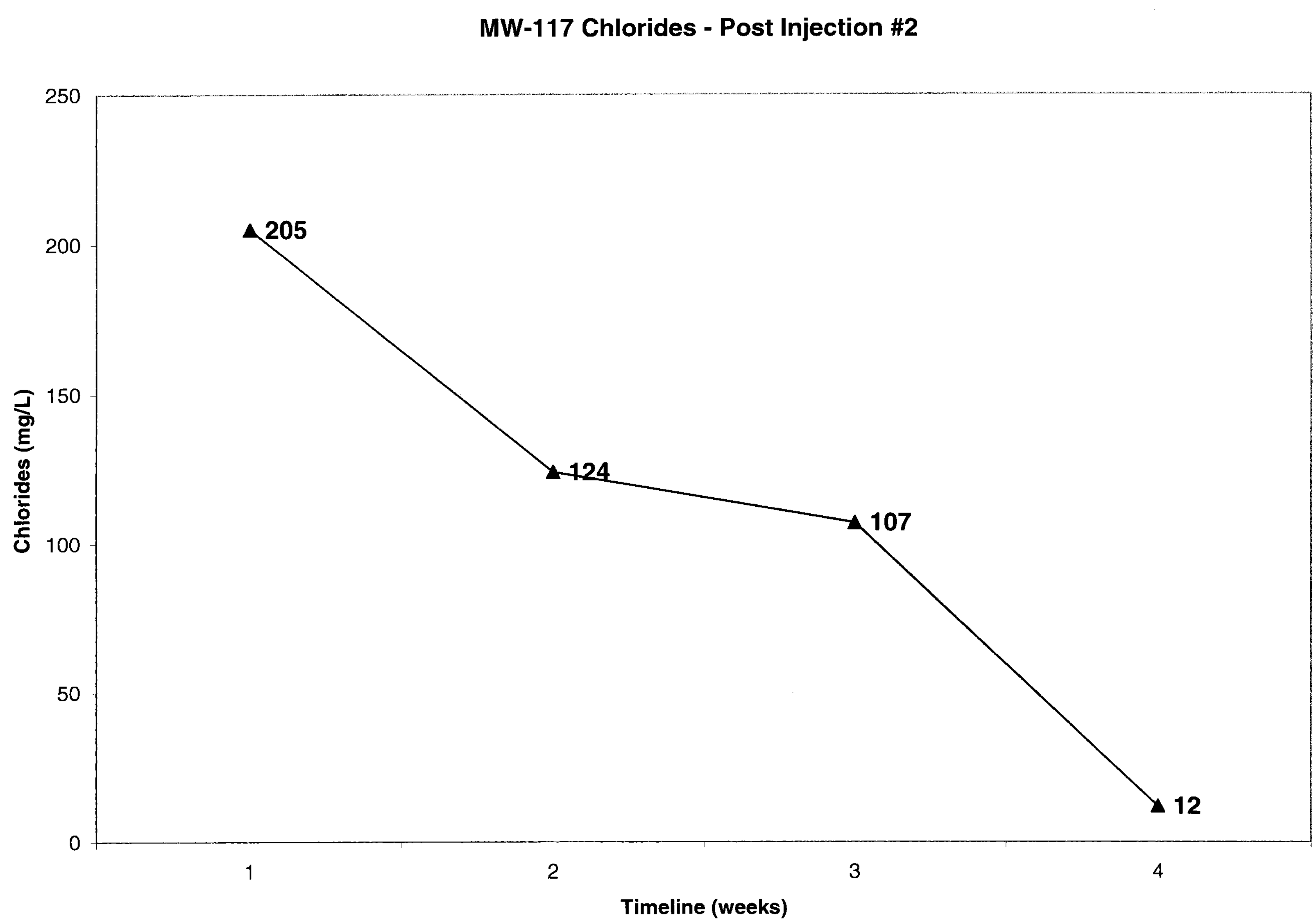


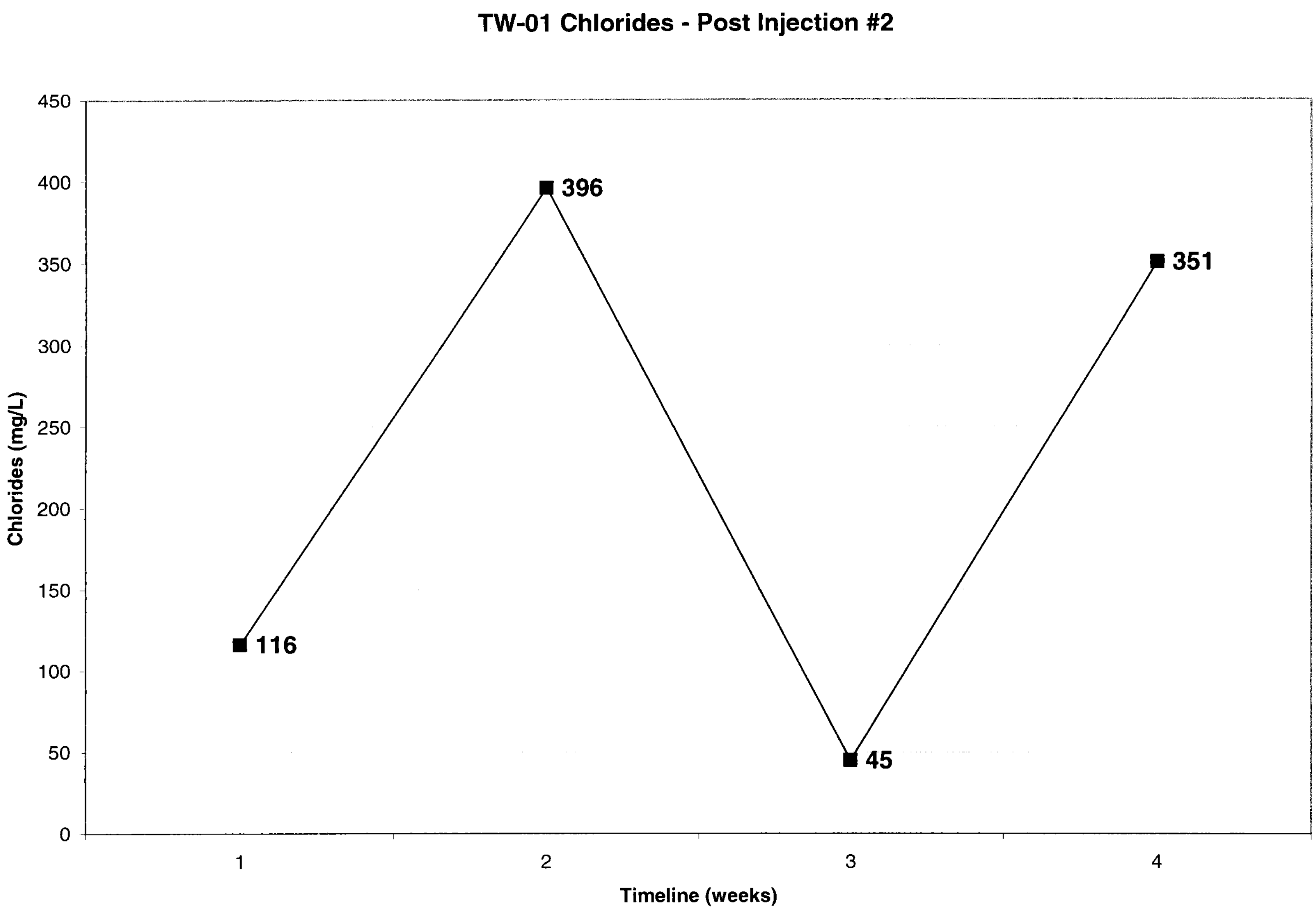
MW-117 Chlorides - Post Injection #1
Chlorides (mg/L)
12
11.5
11
10.5
10
9.5
9
8.5
8
11.7
11.4
11
9.84
9.46
8.99
1
2
3
4
5
6
Timeline (weeks)

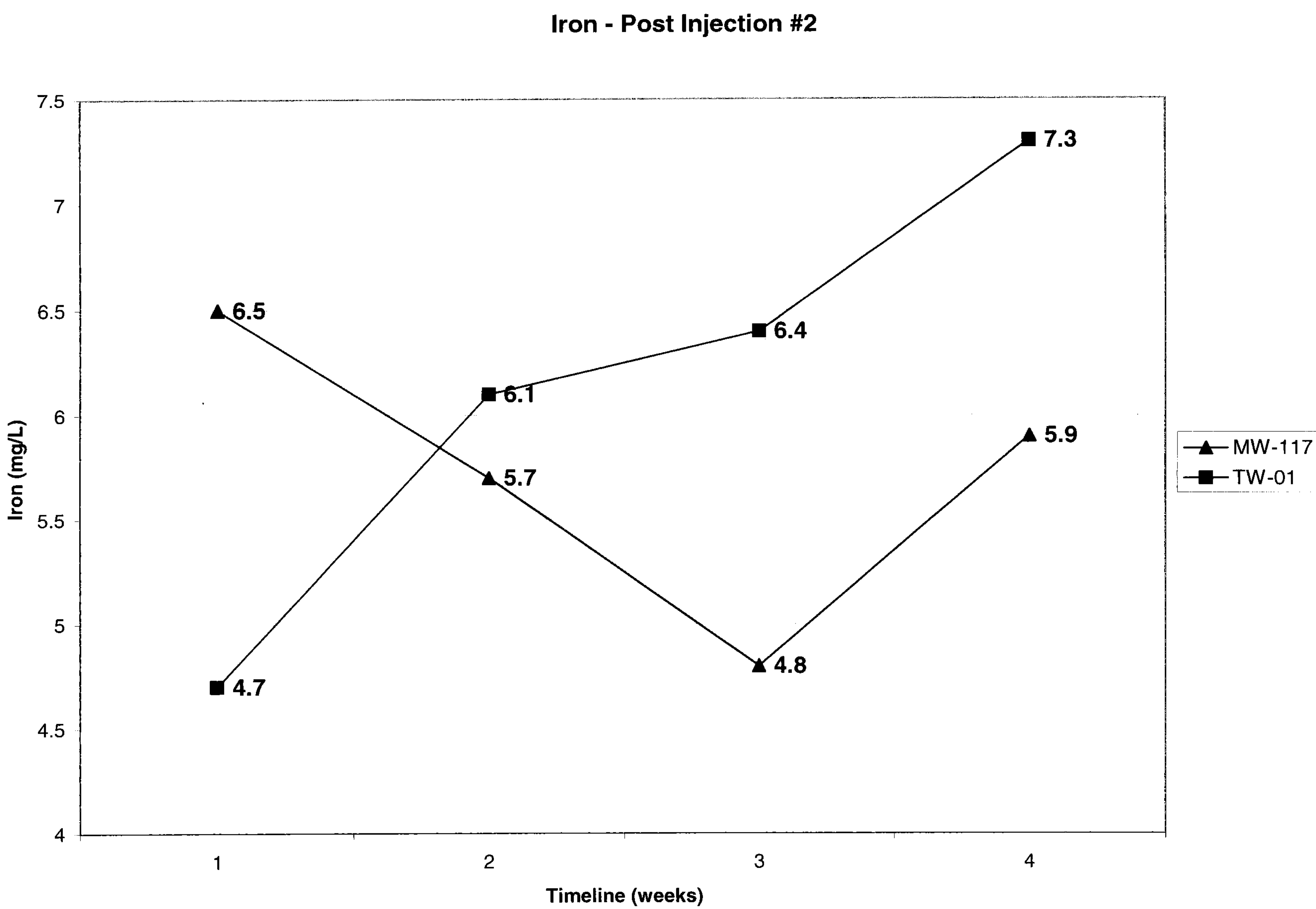

TW-01 Chlorides - Post Injection #1
Chlorides (mg/L)
37.5
37
36.5
36
35.5
35
34.5
34
33.5
33
32.5
34.2
35
34.2
35.7
34.7
37
1
2
3
4
5
6
Timeline (weeks)



Iron - Post Injection #1
Iron (mg/L)
Timeline (weeks)
9
8
7
6
5
4
3
2
1
1
2
3
4
5
6
8.29
8.16
7.94
6.95
6.6
2.38
2.48
1.9
5.45
3.8
8.25
6.65
MW-117
TW-01


MW-117 Chlorides - Post Injection #2
250
200
150
100
50
0
Chlorides (mg/L)
205
124
107
12
1
2
3
4
Timeline (weeks)


TW-01 Chlorides - Post Injection #2
Chlorides (mg/L)
0
50
100
150
200
250
300
350
400
450
1
2
3
4
Timeline (weeks)
116
396
45
351


Iron - Post Injection #2
Iron (mg/L)
7.5
7
6.5
6
5.5
5
4.5
4
1
2
3
4
Timeline (weeks)
6.5
5.7
4.8
5.9
4.7
6.1
6.4
7.3
MW-117
TW-01