N00164.AR.000386
NSWC CRANE
5090.3a

Final
Quality Assurance Project Plan
for
RCRA Ground Water Monitoring
at the
Ammunition Burning Grounds, Old Rifle Range, and Demolition Range

Naval Surface Warfare Center
Crane Division
Crane, Indiana

Volume I - Text

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0038

February 1999

DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
300 HIGHWAY 361
CRANE, INDIANA 47522-5001

IN REPLY REFER TO

5090
Ser 095/0099

08 MAY 2000

U.S. Environmental Protection Agency, Region V
Waste, Pesticides, & Toxics Division
Waste Management Branch
Illinois, Indiana, and Michigan Section
ATTN: Mr. Peter Ramanauskas (DW-8J)
77 West Jackson Blvd.
Chicago, IL 60604

Dear Mr. Ramanauskas:

Crane Division, Naval Surface Warfare Center (NAVSURFWARCENDIV Crane) submits, as enclosure (1) a revised Table 1-3 from the Quality Assurance Project Plan (QAPP) for ground water monitoring at the Subpart X units. The revision replaces the PNA SIM analyses (8270-SIM) with the normal GC/MS method (8270). Although the laboratory reporting limits changed, they are still below the risk based target levels. Note that Method 8270 is already an approved standard operating procedure in the QAPP. The revision affects the following semivolatile compounds: 2-methylnaphthalene, acenaphthene, acenappthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. Also note that the laboratory method detection limit for 2-methylnaphthalene is revised from $0.019^{\mu g}/_{l}$ to $0.64^{\mu g}/_{l}$.

Enclosure (2) contains the revised Table 4-10, page 2 of 3 from the Field Sampling Plan (FSP). The new table incorporates changes to the bottles and preservative used for total organic carbon sampling and analysis. The permit required Certification Statement is provided as enclosure (3).

NAVSURFWARCENDIV Crane point of contact is Mr. Thomas J. Brent, Code 09510, telephone 812-854-6160.

Sincerely,

Thomas J. Brent,
for James M. Hunsicker
Director, Environmental
Protection Department
By direction of
the Commander

Encl:
(1) QAPP Table 1-3
(2) FSP Table 4-10
(3) Certification Statement

Copy to:
Administrative Record
IDEM (Doug Griffin)
TTNUS (Ralph Basinski)
COMARCO (Steve Mehay)

Revised Table 1-3
for the
Quality Assurance Project Plan
for
RCRA Ground Water Monitoring
at the
Ammunition Burning Grounds, Old Rifle Range, and Demolition Range

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
ADDITIONAL METALS (SW-846 METHOD 6010B ICP/AES)			
Calcium	112	1000	--
Iron	16	100	300
Magnesium	33	1000	--
Manganese	1.5	15	50
Potassium	147	1000	--
Sodium	28	1000	--
APPENDIX IX VOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8260B WITH 25 ML PURGE)			
1,1,1-Trichloroethane	0.17	0.5	88
1,1,1,2-Tetrachloroethane	0.13	0.5	5
1,1,2,2-Tetrachloroethane	0.10	0.5	5
1,1,2-Trichloroethane	0.14	0.5	5
1,2,3-Trichloropropane	0.54	1[4]	12.11
1,2,3-Trichlorobenzene	0.08	0.5	--
1,1-Dichloroethane	0.17	0.5	47
1,1-Dichloroethene	0.12	0.5	0.5
1,1-Dichloropropylene	0.15	0.5	--
1,2-Dibromo-3-chloropropane	0.30	1	1
1,2-Dibromoethane	0.13	0.5	1
1,2-Dichloroethane	0.14	0.5	1
1,2-Dichloropropane	0.14	0.5	380
1,3-Dichloropropane	0.15	0.5	--
2,2-Dichloropropane	0.18	0.5	--
2-Butanone	0.86	10	917.72
2-Chloro-1,3-butadiene (chloroprene)	0.40	3	14
2-Hexanone	0.92	10	--
4-Methyl-2-pentanone	0.52	10	1520
Acetone	1.8	10	610
Acrolein	4.6	10*	4
Acrylonitrile	1.3	3	3.7
Allyl chloride (3-chloro-1-propene)	0.22	10	1800
Benzene	0.013	0.5	5
Bromochloromethane	0.18	0.5	--
Bromodichloromethane	0.13	0.5	100
Bromoform	0.18	0.5	8.5
Bromomethane	0.59	1[4]	8.7
Carbon disulfide	0.13	0.5	21
Carbon tetrachloride	0.17	0.3[4]*	0.17
Chlorobenzene	0.18	0.5	10
Chloroethane	0.21	0.5	710
Chloroform	0.14	0.3*	0.16
Chloromethane	0.17	0.5	1.5
cis-1,2-Dichloroethene	0.10	0.5	61
cis-1,3-Dichloropropene	0.16	0.3[4]*	0.081
Dibromochloromethane	0.10	0.5	1
Dibromomethane	0.19	0.5	370
Dichlorodifluoromethane	0.18	0.5	390
Ethylbenzene	0.076	0.5	17.2

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 3 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
Ethyl methacrylate	0.31	1	550
Methacrylonitrile	0.15	1	1
Methylene chloride	0.19	3	4.3
Methyl iodide	0.28	0.5	--
Methyl methacrylate	0.29	2	2800
Styrene	0.10	0.5	56
Tetrachloroethene	0.16	0.5	1.1
Toluene	0.04	0.5	253
trans-1,2-Dichloroethene	0.10	0.5	100
trans-1,3-Dichloropropene	0.10	0.5	0.5
trans-1,4-Dichloro-2-butene	0.34	10	10
Trichloroethene	0.12	0.5	1.6
Trichlorofluoromethane	0.14	0.5	1300
Vinyl acetate	0.21	0.5	248.03
Vinyl chloride	0.20	0.5	2
Total Xylenes	0.18	1	1.8
APPENDIX IX VOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8015B WITH 10 ML PURGE)			
1,4-Dioxane (SW-846 Method 8015B)	66	500*	2
Acetonitrile (SW-846 Method 8015B)	7.6	40	220
Isobutyl alcohol (SW-846 Method 8015B)	3.4	40	11000
Propionitrile (SW-846 Method 8015B)	2.9	40	6080
APPENDIX IX SEMIVOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8270C; 8270C SIM WHERE NOTED)			
1,2,4,5-Tetrachlorobenzene	2.7	10	10
1,2,4-Trichlorobenzene	0.43	2	70
1,2-Dichlorobenzene	0.74	2	14
1,3-Dichlorobenzene	0.68	2	71
1,4-Dichlorobenzene	0.65	2	5
1,4-Naphthoquinone	3.7	10	10
1,4-Phenylenediamine	25	100	6900
1-Naphthylamine	18	36*	10
2,3,4,6-Tetrachlorophenol	12	25*	14.06
2,4,5-Trichlorophenol	2.1	5	63
2,4,6-Trichlorophenol	0.89	3*	2
2,4-Dichlorophenol	1.49	3	18
2,4-Dimethylphenol	1.44	5	166.9
2,4-Dinitrophenol	0.12	10	10
2,6-Dichlorophenol	5.4	5	--
2-Acetylaminofluorene	4.2	12	14.86
2-Chloronaphthalene	0.60	2*	1
2-Chlorophenol	1.4	3*	2
2-Methylnaphthalene	0.64	0.2	9.15
2-Methylphenol	0.36	2	1520
2-Naphthylamine	5.2	16	--
2-Nitroaniline	0.60	2	2.2
2-Nitrophenol	1.1	5	13.5
2-Picoline	9.2	20	3790
3,3'-Dichlorobenzidine	0.59	10	10
3,3'-Dimethylbenzidine	25	50*	10

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 4 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
3-Methylcholanthrene	3.9	12	400
3-, 4-Methylphenol[5]	0.70	4	1800
3-Nitroaniline	0.54	2	--
4,6-Dinitro-2-methylphenol	0.31	10	10
4-Aminobiphenyl	3.4	12	--
4-Bromophenyl phenyl ether	0.31	2	2
4-Chloro-3-methylphenol	0.66	2	34.79
4-Chloroaniline	0.60	2	121.6
4-Chlorophenyl phenyl ether	0.24	1	1
4-Nitroaniline	0.87	2	--
4-Nitrophenol	0.24	10	35
4-Nitroquinoline-1-oxide	11	100	--
5-Nitro-o-toluidine	8.0	16	--
7,12-Dimethylbenz(a)anthracene	7.0	10[4]	10
Acenaphthene	0.008	0.2	23
Acenaphthylene	0.011	0.2	1
Acetophenone	3.3	20	687.89
Aniline	0.52	5	5
Aramite	4.0	10	10
Anthracene	0.018	0.2	5
Benzo(a)anthracene	0.014	0.2	1
Benzo(a)pyrene	0.015	0.2	1
Benzo(b)fluoranthene	0.016	0.2	1
Benzo(g,h,i)perylene	0.014	0.2	1
Benzo(k)fluoranthene	0.018	0.2	1
Benzyl alcohol	0.62	10	281.24
Bis(2-chloroethoxy)methane	1.0	5	6400
Bis(2-chloroethyl)ether	0.58	1[4]	1
Bis(2-chloroisopropyl)ether	0.29	3	3
Bis(2-ethylhexyl)phthalate	0.46	2	4.8
Butyl benzyl phthalate	0.58	2	19
Chlorobenzilate	3.4	5[4]*	2.5
Chrysene	0.015	0.2	1
Diallate	3.5	10	10
Di-n-butyl phthalate	0.28	2	3
Di-n-octyl phthalate	0.67	2	30
Dibenzo(a,h)anthracene	0.012	0.2	1
Dibenzofuran	0.29	1	13.52
Diethyl phthalate	0.55	2	220
Dimethoate	5.4	10[4]	10
p-(Dimethylamino)azobenzene	3.7	15	--
a,a-Dimethylphenethylamine	17	50	--
Dimethyl phthalate	0.28	2	73
Diphenylamine[6]	3.6	10	10
Disulfoton	8.54	16[4]*	0.3
Ethyl methane sulfonate	4.80	16	--
Ethyl parathion	5.23	15	--
Famphur	2.60	10	--

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 5 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
Fluoranthene	0.014	0.2	8.1
Fluorene	0.015	0.2	10
Hexachlorobenzene	0.30	2	2
Hexachlorobutadiene	0.63	1[4]	1
Hexachlorocyclopentadiene	0.05	2	2
Hexachloroethane	0.71	2	4.8
Hexachloropropene	4.0	20	20
Indeno(1,2,3-cd)pyrene	0.008	0.2	1
Isodrin	3.4	10	10
Isophorone	0.48	1	71
Isosafrole	2.9	20	--
Kepone	6.2	25*	0.7
Methapyrilene	17	40	--
Methyl methane sulfonate	4.1	16	--
Methyl parathion	4.98	10*	9.1
n-Nitrosodi-n-butylamine	4.7	10	10
n-Nitrosodiethylamine	3.3	10	10
n-Nitrosodimethylamine	0.44	10	10
n-Nitrosodi-n-propylamine	0.39	2	2
n-Nitrosomethylethylamine	3.6	10	10
n-Nitrosomorpholine	5.3	10[4]	10
n-Nitrosopiperidine	3.6	10	10
n-Nitrosopyrrolidine	3.0	10	10
Naphthalene	0.014	0.2	24
Pentachlorobenzene	4.7	10	10
Pentachloroethane	4.8	10	14.39
Pentachloronitrobenzene	3.8	10	10
Pentachlorophenol	0.97	10	10
Phenacetin	1.6	10	10
Phenanthrene	0.019	0.2	1
Phenol	1.5	5	100
Phorate	5.06	10[4]*	3.62
Pronamide	3.3	12	160
Pyrene	0.017	0.2	1
Pyridine	1.2	10	37
Safrole	2.7	20	40
Tetraethyl dithiopyrophosphate (Sulfotepp)	3.5	10	10
Thionazin	4.0	100	--
o-Toluidine	5.2	15	--
O,O,O-Triethyl phosphorothioate	4.6	10	10
APPENDIX IX ORGANOCHLORINE PESTICIDES and PCBs (SW-846 METHOD 8081)			
Aldrin	0.0028	0.01	0.01
Alpha-BHC	0.0031	0.01	0.01
Alpha-chlordane	0.0020	0.03	0.03
Beta-BHC	0.0024	0.03	0.037
4,4'-DDD	0.0035	0.05	0.05
4,4'-DDE	0.0029	0.05*	0.01
4,4'-DDT	0.0048	0.05*	0.01

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 6 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
Delta-BHC	0.0020	0.05	666.67
Dieldrin	0.0060	0.02	0.02
Endosulfan I	0.0033	0.05	0.051
Endosulfan II	0.0052	0.05	0.051
Endosulfan sulfate	0.0061	0.05	0.05
Endrin	0.0084	0.06	0.06
Endrin aldehyde	0.0069	0.05	0.05
Gamma-BHC (Lindane)	0.0037	0.05	0.052
Gamma-chlordane	0.0022	0.03	0.03
Heptachlor	0.0030	0.03	0.03
Heptachlor epoxide	0.0023	0.01	0.01
Methoxychlor	0.0226	0.12*	0.05
Toxaphene	1.1	3.0*	2.4
Aroclor-1016	0.094	0.5	0.5
Aroclor-1221	0.084	0.5	0.5
Aroclor-1232	0.23	0.5	0.5
Aroclor-1242	0.37	0.5[4]	0.5
Aroclor-1248	0.11	0.5	0.5
Aroclor-1254	0.11	0.5	0.5
Aroclor-1260	0.095	0.5	0.5
APPENDIX IX HERBICIDES (SW-846 METHOD 8151A)			
2,4-D	0.021	0.2	70
2,4,5-T	0.011	0.2	370
2,4,5-TP (Silvex)	0.003	0.2	50
Dinoseb	0.035	0.2	0.39
Hexachlorophene	0.034	0.5	11
DIOXINS/FURANS (SW-846 METHOD 8290)			
2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)	6.1E-6	1E-5*	4.5E-6
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (1,2,3,7,8-PeCDD)	2.24E-5	5E-5*	9E-6[7]
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,6,7,8-HxCDD)	9.8E-6	5E-5*	4.5E-5[7]
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,4,7,8-HxCDD)	6.1E-6	5E-5*	4.5E-5[7]
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (1,2,3,7,8,9-HxCDD)	1.76E-5	5E-5*	4.5E-5[7]
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	1.78E-5	5E-5	4.5E-4[7]
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (1,2,3,4,6,7,8,9-OCDD)	2.6E-5	1E-4	4.5E-3[7]
2,3,7,8-Tetrachlorodibenzofuran (2,3,7,8-TCDF)	6.6E-6	1E-5	4.5E-5[7]
1,2,3,7,8-Pentachlorodibenzofuran (1,2,3,7,8-PeCDF)	1.49E-5	5E-5	9E-5[7]
2,3,4,7,8-Pentachlorodibenzofuran (2,3,4,7,8-PeCDF)	1.62E-5	5E-5*	9E-6[7]
1,2,3,6,7,8-Hexachlorodibenzofuran (1,2,3,6,7,8-HxCDF)	1.62E-5	5E-5*	4.5E-5[7]
1,2,3,7,8,9-Hexachlorodibenzofuran (1,2,3,7,8,9-HxCDF)	1.42E-5	5E-5*	4.5E-5[7]
1,2,3,4,7,8-Hexachlorodibenzofuran (1,2,3,4,7,8-HxCDF)	1.93E-5	5E-5*	4.5E-5[7]
2,3,4,6,7,8-Hexachlorodibenzofuran (2,3,4,6,7,8-HxCDF)	2.4E-5	5E-5*	4.5E-5[7]
1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	1.88E-5	5E-5	4.5E-4[7]
1,2,3,4,7,8,9-Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)	2.84E-5	5E-5	4.5E-4[7]
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (1,2,3,4,6,7,8,9-OCDF)	3.03E-5	1E-4	4.5E-3[7]
Total Tetrachlorodibenzo-p-dioxin (Total TCDD)	NA[8]	1E-5	NA
Total Pentachlorodibenzo-p-dioxin (Total PeCDD)	NA	5E-5	NA
Total Hexachlorodibenzo-p-dioxin (Total HxCDD)	NA	5E-5	NA
Total Heptachlorodibenzo-p-dioxin (Total HpCDD)	NA	5E-5	NA

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 7 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
Total Tetrachlorodibenzofuran (Total TCDF)	NA	1E-5	NA
Total Pentachlorodibenzofuran (Total PeCDF)	NA	5E-5	NA
Total Hexachlorodibenzofuran (Total HxCDF)	NA	5E-5	NA
Total Heptachlorodibenzofuran (Total HpCDF)	NA	5E-5	NA
MISCELLANEOUS PARAMETERS			
Ammonia (EPA Method 350.1)	6.4	10	--
Chloride (SW-846 Method 9056)	80	1000	--
Cyanide (SW-846 Method 9012A)	2.4	10	10
Dissolved Ethane (Microseeps, Inc., Method AM18)	0.0008	0.005	100[9]
Dissolved Ethene (Microseeps, Inc., Method AM18)	0.0013	0.005	10[9]
Dissolved Methane (Microseeps, Inc., Method AM18)	0.005	0.015	5[9]
Phosphorus (Total and Dissolved) (EPA Method 365.2)	31.2	100	--
Sulfate (SW-846 Method 9056)	74.2	1000	--
Sulfide (SW-846 Method 9034)	800	1000	--
Total Organic Carbon (TOC) (SW-846 Method 9060)	306	1000	--
Total Organic Halides (TOX) (SW-846 Method 9020B)	8.8	20	--

ug/L micrograms per liter

* Asterisks indicate those chemicals for which the laboratory RL exceeds the risk-based target level for the project.

1 Method detection limits (MDLs) (all parameters except metals), instrument detection limits (IDLs) (metals only), and reporting limits (RLs) as provided by Laucks Testing Laboratories, Inc., Triangle Laboratories, Inc. (dioxins/furans only), and Microseeps, Inc. (dissolved methane only). These values may change throughout the course of the ground water monitoring program as laboratory MDLs and IDLs are updated.

2 Developed using U.S. EPA Region 5 support. Value is based on human health or ecological risk-based criteria or practical quantitation limits (PQLs) for common laboratory analytical methods.

3 Risk-based target level is not provided, since human and ecological risk-based criteria are not available for this chemical.

4 Laucks Testing Laboratories is confident that it can reliably report to this PQL, even though this value is less than two times the MDL.

5 3-Methylphenol and 4-methylphenol coelute. Therefore, one analytical result for 3-, 4-methylphenol will be reported.

6 N-Nitrosodiphenylamine is more toxic than diphenylamine. However, n-nitrosodiphenylamine rapidly degrades to diphenylamine. Therefore, only diphenylamine will be reported, but results for diphenylamine will be treated as n-nitrosodiphenylanina during risk assessment.

7 The target level is calculated using the target level for 2,3,7,8-TCDD and the toxicity equivalent factor (TEF) presented in current U.S. EPA guidance (U.S. EPA, March 1989).

8 Not applicable.

9 The target levels for dissolved ethane, ethene, and methane are not risk-based values, but instead represent the target reporting levels for these dissolved gases based on their use in evaluating the natural attenuation of TCE.

Revised Table 4-10
for the
Field Sampling Plan
for
RCRA Ground Water Monitoring
at the
Ammunition Burning Grounds, Old Rifle Range, and Demolition Range

TABLE 4-10

SUMMARY OF SAMPLE ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 3

Parameter	Sample Container	Container Volume	Preservation[1]	Maximum Holding Time[2]	Analytical Methodology
Appendix IX Organochlorine Pesticides/Polychlorinated biphenyls (PCBs)	Amber glass, Teflon-lined cap	(2) 1000 mL[3]	Cool to 4°C, dark	Extraction 7 days; analysis within 40 days of extraction	SW-846 Method 8081
Appendix IX Herbicides	Amber glass, Teflon-lined cap	(2) 1000 mL[3]	Cool to 4°C, dark	Extraction 7 days; analysis within 40 days of extraction	SW-846 Method 8151A
Dioxins/Furans	Amber glass, Teflon-lined cap	(2) 1000 mL[3]	Cool to 4°C, dark	Extraction 30 days; analysis within 45 days of extraction	SW-846 Method 8290
Ammonia	Polyethylene bottle, plastic cap, plastic liner	500 mL[14]	Cool to 4°C, H_2SO_4 to pH <2	28 days	EPA Method [15] 350.1
Chloride	Polyethylene bottle, plastic cap, plastic liner	500 mL[16]	Cool to 4°C	28 days	SW-846 Method 9056
Cyanide	Polyethylene bottle, plastic cap, plastic liner	500 mL	Cool to 4°C, NaOH to pH > 12	Within 14 days	SW-846 Method 9012A
Dissolved Methane, Ethene, and Ethane	Amber glass, plastic cap Mylar-faced silicon septum	(2) 40 mL	Cool to 4°C, dark, zero headspace	14 days	Microseeps Method AM18.01[17]
Phosphorus (Total and Dissolved)	Polyethylene bottle, plastic cap, plastic liner	500 mL[14]	Cool to 4°C, H_2SO_4 to pH <2	28 days	EPA Method 365.2
Sulfate	Polyethylene bottle, plastic cap, plastic liner	500 mL[16]	Cool to 4°C	28 days	SW-846 Method 9056
Sulfide	Polyethylene bottle, plastic cap, plastic liner	500 mL	Cool to 4°C, zinc acetate, NaOH to pH >9	7 days	SW-846 Method 9030B/9034
Total Organic Carbon (TOC)	Amber glass, septa cap	(2) 40 mL	Cool to 4°C, H_3PO_4 to pH <2	28 days	SW-846 Method 9060
Total Organic Halides (TOX)	Amber glass, Teflon-lined cap	1000 mL	Cool to 4°C, H_2SO_4 to pH <2	28 days	SW-846 Method 9020B

TABLE 4-10

SUMMARY OF SAMPLE ANALYSIS, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 3 OF 3

1 HCl = Hydrochloric acid, H_2SO_4 = Sulfuric Acid, NaOH = Sodium Hydroxide, HNO_3 = Nitric Acid

2 All holding times are from date of collection.

3 Two additional 1,000-mL bottles are required for samples designated for matrix spike/matrix spike duplicate analysis (minimum 1 in 20 samples).

4 U.S. EPA, 1986. Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, 3rd ed, including updates.

5 Based on Indiana Army Ammunition Plant Contamination Survey. "Nitrocellulose in Water". Aqualab, Inc., 1983.

6 Laucks SOP LTL-8308, included in Appendix B of the QAPP.

7 One 1,000-mL bottle of unfilltered ground water will provide sufficient sample volume for the analysis for Appendix IX metals (total) and/or any additional total metals analyses. Likewise, one 1,000-mL bottle of filtered ground water will provide sufficient sample volume for the analysis for Appendix IX metals (dissolved) and/or any additional dissolved metals analyses.

8 One additional 1,000-mL bottle is required for samples designated for matrix spike/duplicate analysis (minimum 1 in 20 samples).

9 Eight additional 40-mL vials are required for samples designated for matrix spike/matrix spike duplicate analysis (minimum 1 in 20 samples).

10 Analysis will be performed using a 25-mL sample volume in order to achieve lower quantitation limits for ground water samples.

11 Three 40-mL vials will provide sufficient sample volume for the analysis of trichloroethene and its degradation products (volatile subset B) and aromatic and chlorinated hydrocarbons (volatile subset C). In addition, when samples are collected for analysis of the Appendix IX volatile list (six 40-mL vials), it is not necessary to collect any additional vials for volatile subsets B and C because the analytes included in volatile subsets B and C are completely contained within the Appendix IX volatile list.

12 Four additional 40-mL vials are required for samples designated for matrix spike/matrix spike duplicate analysis (minimum 1 in 20 samples).

13 Four additional 1,000-mL bottles are required for samples designated for matrix spike/matrix spike duplicate analysis (minimum 1 in 20 samples).

14 Ammonia and total phosphorus samples will be provided for analysis in the same 500-mL bottle.

15 U.S. EPA, 1983. Methods for Chemical Analysis of Water and Wastes.

16 Chloride and sulfate samples will be provided for analysis in the same 500-mL bottle.

17 Microseeps Method AM18.01, included in Appendix B of the QAPP.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Thomas F. Brent, acting
SIGNATURE

Environmental Protection Specialist
TITLE

08 MAY 2000
DATE

Enclosure (3)

April 17, 2000

Ralph,

Enclosed are 6 copies of the QAPP signature page for distribution back to the various TtNUS folks as well as your subcontract labs.

Thanks,
Tom

QUALITY ASSURANCE PROJECT PLAN
FOR
RCRA GROUND WATER MONITORING
AT THE
AMMUNITION BURNING GROUNDS,
OLD RIFLE RANGE, AND DEMOLITION RANGE

NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
CRANE, INDIANA

REVISION 2
FEBRUARY 1999

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0038

Ralph R. Basinski Date 10/27/99
RALPH R. BASINSKI, Q.E.P.
TASK ORDER MANAGER
TETRA TECH NUS, INC.

Debbie Wroblewski Date 4/12/00
DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.

Paul V. Frank Date 4-12-00
PAUL V. FRANK
QUALITY ASSURANCE MANAGER
TETRA TECH NUS, INC.

Allen A. Debus Date 4-14-99
ALLEN DEBUS
QUALITY ASSURANCE COORDINATOR
U.S. EPA REGION 5

Carol Witt-Smith Date 5/20/99
CAROL WITT-SMITH
PERMITTING PROJECT MANAGER
U.S. EPA REGION 5

_____ Date _____
PAUL FREED
FACILITY PERMIT MANAGER
NSWC CRANE

Kathy Kreps Date 03-29-00
KATHY KREPS
LABORATORY DIRECTOR
LAUCKS TESTING LABORATORIES, INC.

Belen Rueda Date 4/04/00
~~BELEN RUEDA~~
~~LABORATORY MANAGER~~
TRIANGLE LABORATORIES, INC.
Frank Stevens
Co Director Analytical Services

Allan Sprayberry Date 4/10/00
ALLAN SPRAYBERRY
AIR LABORATORY DIRECTOR
MICROSEEPS, INC.

QUALITY ASSURANCE PROJECT PLAN
FOR
RCRA GROUND WATER MONITORING
AT THE
AMMUNITION BURNING GROUNDS,
OLD RIFLE RANGE, AND DEMOLITION RANGE

NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
CRANE, INDIANA

REVISION 2
FEBRUARY 1999

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0038

Ralph R. Basinski Date 10/27/99
RALPH R. BASINSKI, Q.E.P.
TASK ORDER MANAGER
TETRA TECH NUS, INC.

Paul V. Frank Date 4-12-00
PAUL V. FRANK
QUALITY ASSURANCE MANAGER
TETRA TECH NUS, INC.

Carol Witt-Smith Date 5/20/99
CAROL WITT-SMITH
PERMITTING PROJECT MANAGER
U.S. EPA REGION 5

Kathy Kreps Date 03-29-00
KATHY KREPS
LABORATORY DIRECTOR
LAUCKS TESTING LABORATORIES, INC.

Allan Sprayberry Date 4/10/00
ALLAN SPRAYBERRY
AIR LABORATORY DIRECTOR
MICROSEEPS, INC.

Debbie Wroblewski Date 4/12/00
DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.

Allen A. Debus Date 4-14-99
ALLEN DEBUS
QUALITY ASSURANCE COORDINATOR
U.S. EPA REGION 5

Thomas J. Brent Date 4/13/00
~~PAUL FREED~~ Thomas J. Brent
~~FACILITY PERMIT~~ MANAGER
NSWC CRANE
Ground Water Program

Belen Rueda Date 4/04/00
~~BELEN RUEDA~~
~~LABORATORY MANAGER~~
TRIANGLE LABORATORIES, INC.
Frank Stevens
Co Director Analytical Services

TETRA TECH NUS, INC.
661 Andersen Drive ▪ Pittsburgh, Pennsylvania 15220-2745
(412) 921-7090 ▪ FAX (412) 921-4040 ▪ www.tetratech.com

PITT 04-0-042

April 11, 2000

Project Number 7651

Commanding Officer
Department of the Navy
SOUTHNAVFACENGCOM
Attn: E. P. Johns (Code 1829)
2155 Eagle Drive
North Charleston, South Carolina 29406

Reference: CLEAN Contract No. N62472-90-D-1298
Contract Task Order 0038

Subject: Final Quality Assurance Project Plan (QAPP) for RCRA Ground Water Monitoring at the Ammunition Burning Grounds, Old Rifle Range, and Demolition Range

Dear Mr. Johns:

Enclosed is the final cover for the QAPP.

Please revise the draft final QAPP as follows:

1. Replace the existing cover and spine for Volume 1 of 2 with the enclosed cover and spine.

2. Replace the existing cover and spine for Volume 2 of 2 with the enclosed cover and spine.

The signatory page is not included. The original signatory page has been forwarded under separate cover to Mr. Tom Brent at NSWC Crane for signature and forwarding to U.S. EPA Region V. He will provide copies of the signatory page to all holders of the QAPP.

No other changes are required to finalize the QAPP,

Please contact Ralph Basinski at 412-921-8308 (e-mail basinski@ttnus.com) regarding any questions or comments.

Sincerely,

Ralph R. Basinski
Task Order Manager

RRB/vvp

Enclosures

cc: Mr. Tom Brent, NSWC Crane (4 copies)
Ms. D. Wroblewski (Letter Only)
Ms. D. Resnick (1 copy)
Mr. M. Perry/File CTO 0038 (1 copy)
Working File CTO 0038 (1 copy)

TETRA TECH NUS, INC.
661 Andersen Drive ▪ Pittsburgh, Pennsylvania 15220-2745
(412) 921-7090 ▪ FAX (412) 921-4040 ▪ www.tetratech.com

PITT 04-0-045

April 12, 2000

Mr. Tom Brent
Naval Surface Warfare Center
Code 09510 Building 3260
300 Highway 361
Crane, Indiana 47522-5009

Reference: CLEAN Contract Number N62472-90-D-1298
Contract Task Order 0038

Subject: Original Signature Page for Final Quality Assurance Project Plan (QAPP) for RCRA Ground Water Monitoring at the Ammunition Burning Grounds, Old Rifle Range, and Demolition Range

Dear Mr. Brent

Enclosed is the subject original signatory page. All signatures have been completed with the exception of the signature of the NSWC Crane permit manager. When signed, please provide holders of the plan with copies of the signatory page.

Please contact Ralph Basinski at 412-921-8308 (e-mail basinski@ttnus.com) regarding any questions or comments.

Sincerely,

Ralph R. Basinski
Task Order Manager

RRB/vvp

Enclosure

cc: Mr. E.P. Johns (letter only)
Ms. D. Wroblewski (letter only)
Ms. D. Resnick (letter only))
Mr. M. Perry/File CTO 0038 (1 copy)
Working File CTO 0038 (1 copy)

QUALITY ASSURANCE PROJECT PLAN
FOR
RCRA GROUND WATER MONITORING
AT THE
AMMUNITION BURNING GROUNDS,
OLD RIFLE RANGE, AND DEMOLITION RANGE

NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
CRANE, INDIANA

REVISION 2
FEBRUARY 1999

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
Tetra Tech NUS, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0038

Ralph R. Basinski Date 10/27/99
RALPH R. BASINSKI, Q.E.P.
TASK ORDER MANAGER
TETRA TECH NUS, INC.

Debbie Wroblewski Date 4/12/00
DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.

Paul V. Frank Date 4-12-00
PAUL V. FRANK
QUALITY ASSURANCE MANAGER
TETRA TECH NUS, INC.

Allen A. Debus Date 4-14-99
ALLEN DEBUS
QUALITY ASSURANCE COORDINATOR
U.S. EPA REGION 5

Carol Witt-Smith Date 5/20/99
CAROL WITT-SMITH
PERMITTING PROJECT MANAGER
U.S. EPA REGION 5

Thomas J. Brent Date 4/13/00
~~PAUL FREED~~ Thomas J. Brent
~~FACILITY PERMIT~~ MANAGER
NSWC CRANE
Ground Water Program

Kathy Kreps Date 03-29-00
KATHY KREPS
LABORATORY DIRECTOR
LAUCKS TESTING LABORATORIES, INC.

Date 4/04/00
~~BELEN RUEDA~~
~~LABORATORY MANAGER~~
TRIANGLE LABORATORIES, INC.
Frank Stevens
Co Director Analytical Services

Allan Sprayberry Date 4/10/00
ALLAN SPRAYBERRY
AIR LABORATORY DIRECTOR
MICROSEEPS, INC.

TABLE OF CONTENTS

VOLUME I

SECTION **PAGE NO.**

ACRONYMS **6**

1.0 PROJECT DESCRIPTION **1-1**
1.1 INTRODUCTION 1-2
1.1.1 Overall Project Objectives 1-2
1.1.2 Project Status/Phase 1-13
1.1.3 QAPP Preparation Guidelines 1-16
1.2 SITE/FACILITY DESCRIPTION 1-16
1.2.1 Location 1-16
1.2.2 Facility Size and Borders 1-17
1.2.3 Natural and Manmade Features 1-17
1.2.4 Topography 1-17
1.2.5 Local Hydrology and Hydrogeology 1-18
1.3 FACILITY HISTORY 1-18
1.3.1 General History 1-18
1.3.2 Past Data Collection Activities 1-19
1.3.3 Current Status 1-21
1.4 PROJECT OBJECTIVES 1-23
1.4.1 Specific Objectives and Associated Tasks 1-23
1.4.2 Project Target Parameters and Intended Data Uses 1-23
1.4.3 Data Quality Objectives 1-35
1.5 SAMPLE NETWORK DESIGN AND RATIONALE 1-37
1.5.1 Sample Network by Task and Matrix 1-37
1.5.2 Site Maps of Sampling Locations 1-37
1.5.3 Rationale of Selected Sampling Locations 1-37
1.5.4 Sample Network Summary Table 1-38
1.6 PROJECT SCHEDULE 1-38
1.6.1 Anticipated Date of Project Mobilization 1-38
1.6.2 Task Bar Chart and Associated Timeframes 1-38

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY **2-1**

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA **3-1**
3.1 PRECISION 3-1
3.1.1 Definition 3-1
3.1.2 Field Precision Objectives 3-1
3.1.3 Laboratory Precision Objectives 3-1
3.2 ACCURACY 3-2
3.2.1 Definition 3-2
3.2.2 Field Accuracy Objectives 3-2
3.2.3 Laboratory Accuracy Objectives 3-2
3.3 COMPLETENESS 3-24
3.3.1 Definition 3-24

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

3.3.2 Field Completeness Objectives 3-25
3.3.3 Laboratory Completeness Objectives 3-25
3.4 REPRESENTATIVENESS 3-25
3.4.1 Definition 3-25
3.4.2 Measures to Ensure Representativeness of Field Data 3-25
3.4.3 Measures to Ensure Representativeness of Lab Data 3-25
3.5 COMPARABILITY 3-26
3.5.1 Definition 3-26
3.5.2 Measures to Ensure Comparability of Field Data 3-26
3.5.3 Measures to Ensure Comparability of Lab Data 3-26
3.6 LEVEL OF QC EFFORT 3-26

4.0 SAMPLING PROCEDURES 4-1

5.0 CUSTODY PROCEDURES 5-1
5.1 FIELD CUSTODY PROCEDURES 5-1
5.2 LABORATORY CUSTODY PROCEDURES 5-2
5.3 FINAL EVIDENCE FILES 5-2

6.0 CALIBRATION PROCEDURES AND FREQUENCY 6-1
6.1 FIELD INSTRUMENT CALIBRATION 6-1
6.2 LABORATORY INSTRUMENT CALIBRATION 6-1

7.0 ANALYTICAL AND MEASUREMENT PROCEDURES 7-1
7.1 FIELD MEASUREMENT PROCEDURES 7-1
7.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES 7-1
7.2.1 List of Project Target Compounds and Detection Limits 7-2
7.2.2 List of Associated Quality Control Samples 7-2

8.0 INTERNAL QUALITY CONTROL CHECKS 8-1
8.1 FIELD QUALITY CONTROL CHECKS 8-1
8.2 LABORATORY QUALITY CONTROL CHECKS 8-1

9.0 DATA REDUCTION, VALIDATION, AND REPORTING 9-1
9.1 DATA REDUCTION 9-1
9.1.1 Field Data Reduction 9-1
9.1.2 Laboratory Data Reduction 9-2
9.2 DATA VALIDATION 9-3
9.2.1 Procedures Used to Evaluate Field Data 9-4
9.2.2 Procedures Used to Validate Laboratory Data 9-4
9.3 DATA REPORTING 9-5
9.3.1 Field Data Reporting 9-5
9.3.2 Laboratory Data Reporting 9-5

TABLE OF CONTENTS (CONTINUED)

SECTION **PAGE NO.**

10.0 PERFORMANCE AND SYSTEM AUDITS 10-1
10.1 FIELD PERFORMANCE AND SYSTEM AUDITS 10-1
10.1.1 Internal Field Audits 10-1
10.1.2 External Field Audits 10-3
10.2 LABORATORY PERFORMANCE AND SYSTEMS AUDITS 10-3
10.2.1 Internal Laboratory Audits 10-3
10.2.2 External Laboratory Audits 10-5

11.0 PREVENTIVE MAINTENANCE PROCEDURES 11-1
11.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE 11-1
11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE 11-1

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS 12-1
12.1 ACCURACY ASSESSMENT 12-1
12.2 PRECISION ASSESSMENT 12-2
12.3 COMPLETENESS ASSESSMENT 12-2
12.4 DATA ASSESSMENT 12-2

13.0 CORRECTIVE ACTION 13-1
13.1 FIELD CORRECTIVE ACTION 13-1
13.2 LABORATORY CORRECTIVE ACTION 13-1
13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT 13-3

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT 14-1
14.1 CONTENTS OF PROJECT QUALITY ASSURANCE REPORTS 14-1
14.2 FREQUENCY OF QUALITY ASSURANCE REPORTS 14-2
14.3 INDIVIDUALS RECEIVING/REVIEWING QUALITY ASSURANCE REPORTS 14-2

REFERENCES R-1

VOLUME II

APPENDICES

A HUMAN HEALTH AND ECOLOGICAL RISK-BASED CRITERIA

B STANDARD OPERATING PROCEDURES

C TETRA TECH NUS, INC. AUDIT CHECKLIST

D MICROSEEPS INC., CORRECTIVE ACTION PROCEDURES

TABLES

NUMBER		PAGE NO.
1-1	Summary of RCRA Groundwater Monitoring Requirements	1-3
1-2	Summary of Usable Historical Data	1-14
1-3	Analytical Methods and Limits of Detection	1-24
3-1	Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples and Surrogate Spikes, Explosives Analyses	3-3
3-2	Quality Control Limits, Laboratory Control Samples, Explosives Analyses	3-5
3-3	Quality Control Limits, Matrix Spike and Laboratory Duplicate Samples Metals Analyses	3-7
3-4	Quality Control Limits, Laboratory Control Samples, Metals Analyses	3-8
3-5	Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples and Surrogate Spikes, Volatile Organic Compound Analyses	3-9
3-6	Quality Control Limits, Laboratory Control Samples, Volatile Organic Compound Analyses	3-11
3-7	Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples and Surrogate Spikes, Semivolatile Organic Compound and Organophosphorus Pesticide Analyses	3-12
3-8	Quality Control Limits, Laboratory Control Samples, Semivolatile Organic Compound and Organophosphorus Pesticide Analyses	3-15
3-9	Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples and Surrogate Spikes, Organochlorine Pesticide and PCB Analyses	3-16
3-10	Quality Control Limits, Laboratory Control Samples, Organochlorine Pesticide and PCB Analyses	3-17
3-11	Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples and Surrogate Spikes, Herbicide Analyses	3-18
3-12	Quality Control Limits, Laboratory Control Samples, Herbicide Analyses	3-19
3-13	Quality Control Limits, Matrix Spike/Matrix Spike Duplicate Samples Dioxin/Furan Analyses	3-20
3-14	Quality Control Limits, Laboratory Control Sample/Laboratory Control Sample Duplicates Dioxin/Furan Analyses	3-21
3-15	Quality Control Limits, Matrix Spike and Laboratory Duplicate Samples, Miscellaneous Parameters	3-22
3-16	Quality Control Limits, Laboratory Control Samples, Miscellaneous Parameters	3-23
7-1	Summary of Organic and Inorganic Analytical Procedures, Ground Water Samples	7-3
11-1	Preventive Maintenance for Analytical Instruments	11-2

FIGURES

NUMBER		PAGE NO.
13-1	Tetra Tech NUS, Inc., Field Task Modification Request Form	13-2

ACRONYMS/ABBREVIATIONS

ABG	Ammunition Burning Grounds
ACL	Alternate Concentration Limit
AWQC	Ambient Water Quality Criteria
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action, Navy
CLP	Contract Laboratory Program
COC	Chain of Custody
CVAA	Cold Vapor Atomic Absorption
DFTPP	Decaflourotriphenyl phosphine
DOD	Department of Defense
DQO	Data Quality Objective
DR	Demolition Range
EC	Electron Capture
EDQL	Ecological Data Quality Level
FOL	Field Operations Leader
FSP	Field Sampling Plan
FTMR	Field Task Modification Request
GC	Gas Chromatograph
GC/MS	Gas Chromatography/Mass Spectrometry
GW	Ground Water
HPLC	High Pressure Liquid Chromatography
IAS	Initial Assessment Study
ICP/AES	Inductively Coupled Plasma/Atomic Emission Spectroscopy
ICP/MS	Inductively Coupled Plasma/Mass Spectrometry
IDEM	Indiana Department of Environmental Management
IDL	Instrument Detection Limit
LCS/LCSD	Laboratory Control Sample/Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NA	Not Applicable

NACIP	Navy Assessment and Control of Installation Pollutants
NEESA	Naval Energy and Environmental Support Agency
NEW	Net Explosive Weight
NFESC	Naval Facilities Engineering Service Center
NIST	National Institute of Science and Technology
NSWC	Naval Surface Warfare Center
NTU	Nephelometric Turbidity Units
OB/OD	Open Burning/Open Detonation
OJT	Old Jeep Trail
ORP/Eh	Oxidation-Reduction Potential
ORR	Old Rifle Range
PAHs	Polynuclear Aromatic Hydrocarbons
PARCC	Precision, Accuracy, Representativeness, Comparability, Completeness
PCB	Polychlorinated Biphenyl
PE	Performance evaluation
PQL	Practical Quantitation Limit
PRGs	Preliminary Remediation Goals
psi	Pounds per square inch
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
RBSL	Risk-Based Screening Level
RCRA	Resource Conservation Recovery Act
RFI	RCRA Facility Investigation
RL	Reporting Limit
RPD	Relative Percent Difference
SDG	Sampling Delivery Group
SIM	Selective Ion Monitoring
SOP	Standard Operating Procedure
SOW	Statement of Work
SQL	Sample Quantitation Limit
SVOC	Semivolatile Organic Compounds
TBD	To be determined

TCE	Trichloroethene
TCL	Target Compound List
TEF	Toxicity Equivalent Factor
TOC	Total Organic Carbon
TOM	Task Order Manager
TOX	Total Organic Halides
TtNUS	Tetra Tech NUS, Inc.
U.S. ACE	United States Army Corps of Engineer
U.S. EPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
WES	Waterways Experiment Station
%R	Percent Recovery

1.0 PROJECT DESCRIPTION

This project description for this Quality Assurance Project Plan (QAPP) outlines the overall scope of the ground water monitoring programs to be conducted in accordance with the Resource Conservation and Recovery Act (RCRA) permit issued by United States Environmental Protection Agency (U.S. EPA) Region 5 to the Naval Surface Warfare Center (NSWC) Crane, located in Crane, Indiana. The RCRA permit contains ground water monitoring requirements for three operating units used for the open burning and open detonation of munitions/explosives at NSWC Crane: the Ammunition Burning Grounds (ABG), the Old Rifle Range (ORR), and the Demolition Range (DR). Ground water monitoring is to be conducted in accordance with the Ground Water Monitoring Plan in the approved RCRA Part B Permit Application. The Ground Water Monitoring Plan was developed in accordance with the requirements for RCRA ground water monitoring in 40 Code of Federal Regulations (CFR) 264 Subpart F and U.S. EPA technical guidance (U.S. EPA, 1986a). Compliance with 40 CFR Subpart F also results in compliance with Indiana Department of Environmental Management (IDEM) regulations. The objectives of the groundwater monitoring programs also include compliance with RCRA Section 3004 (u) and (v) Corrective Action requirements at all three units, and 40 CFR Part 265 closure requirements for land disposal units at the ABG.

This project description also outlines the ground water monitoring requirements for the Old Jeep Trail (OJT). The ground water monitoring well network for this unit has not been defined but will be identified following further corrective action investigation activities.

This QAPP presents the organization, objectives, planned activities, and specific Quality Assurance/Quality Control (QA/QC) procedures associated with sample collection and analysis for the approved Ground Water Monitoring Plan. Specific protocols for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses are described. All QA/QC procedures are structured in accordance with applicable U.S. EPA Region 5 and IDEM requirements, regulations, guidance, and technical standards.

This QAPP was prepared in accordance with the U.S. EPA guidance manual entitled "Region 5 Model RCRA Quality Assurance Project Plan" (U.S. EPA Region 5, May 1993) and was reviewed by U.S. EPA Region 5 in accordance with updated guidance entitled the U.S. EPA "Region 5 QAPP Policy" (U.S. EPA Region 5, April 1998). The Naval Facilities Engineering Service Center (NFESC) guidance document entitled "Navy Installation Restoration Laboratory Quality Assurance Guide" (NFESC, February 1996) was also used in establishing the QA/QC requirements specified in this QAPP. U.S. EPA Region 5 human

health Risk-Based Screening Levels (RBSLs) and Ecological Data Quality Levels (EDQLs), as well as other health- and ecological-based criteria, were used in the development of this QAPP to outline facility-specific project objectives, required levels of instrument detection, and intended data usages. The protection of potential human receptors and ecological habitats, including the endangered species, Indiana Bat, was considered because of the interaction between ground water and surface water at NSWC Crane (i.e., the discharge of ground water to springs and streams).

1.1 INTRODUCTION

In this section, the overall scope of the project is described as it relates to the QAPP prepared for the NSWC Crane Ground Water Monitoring Plan, hereinafter referred to as the approved Ground Water Monitoring Plan. Current project status and QAPP preparation guidelines are discussed. This QAPP has been prepared by Tetra Tech NUS, Inc. (TtNUS) on behalf of the United States Navy Southern Division Naval Facilities Engineering Command and NSWC Crane under Contract Number N62467-94-D-0888, Contract Task Order (CTO) 038. A Ground Water Monitoring Plan has also been prepared for the project by TtNUS. In the case of the ABG, ground water discharges directly to surface water through springs. Therefore, for the purpose of this plan, springs are also considered to be "well locations" for compliance. Pertinent QAPP-related information from the Ground Water Monitoring Plan prepared for the facility is incorporated into the QAPP through specific reference. A Field Sampling Plan (FSP) has also been prepared by TtNUS. The FSP has been entirely incorporated into the QAPP through specific reference. After revision in response to U.S. EPA Region 5 and IDEM comments, these documents were approved by U.S. EPA Region 5 and are hereafter referenced as the approved Ground Water Monitoring Plan and the approved FSP.

1.1.1 Overall Project Objectives

The overall objectives of the ground water monitoring programs for each of the operating units at NSWC Crane (ABG, ORR, and DR) are outlined in Table 1-1, under the column entitled "Type of RCRA Program Sampling/Objective." In keeping with these overall objectives, the primary objective of the QAPP for the units is to establish an analytical program for the approved Ground Water Monitoring Plan that will be capable of measuring hazardous constituents at concentrations which are protective of human health and the environment [alternate concentration limits (ACLs)]. U.S. EPA Region 5 RBSLs and EDQLs, Safe Drinking Water Act Maximum Contaminant Levels [MCLs], and surface water protection standards were considered in establishing these ACLs. The data collected must be of sufficient quality to meet the primary objective of the QAPP.

TABLE 1-1

SUMMARY OF RCRA GROUND WATER MONITORING REQUIREMENTS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Type of RCRA Program Sampling/Objective	Analytical Program (All Wells)				Frequency of Sampling	Monitoring Points		
	Parameter Type	Target Constituents	Objective	Limit of Detection		Location[11]	Objective	Evaluations to be Performed
AMMUNITION BURNING GROUND (ABG)								
Type: RCRA Compliance Closure, Corrective Action Program and RCRA 3004(u) program Objectives: • Monitor GW for compliance with GW protection standards outlined in the RCRA Permit (upgradient and downgradient wells) and listed in the approved-Groundwater Monitoring Plan • Monitor existing GW contaminant distribution (Downgradient wells) • Establish background ground water quality for statistical comparisons • Monitor behavior of Karst system • Closure/post-closure monitoring of surface impoundments and waste piles	Field	• Dissolved oxygen • pH • Specific conductivity • Temperature • Turbidity • Oxidation Reduction Potential (ORP)	Determine if the well water is equivalent to formation water (i.e., stability) Evaluate general water quality.	Reporting limit low enough to meet criteria for determination of stability	Quarterly until 2 years after soil removal then semi-annual	Compliance: • Beech Creek 03C25; 03C30 • Beaver Bend 03C03 Upgradient: • Beech Creek 03C17 Downgradient: • Beech Creek 03C04; 03C07; 03C12 03C15; 03C20; 03C26; 03C27; 03C02P2; 03C08P2; 03C09P2	Monitor contaminant distribution Monitor quality of water in each interconnected aquifer underlying the unit Monitor quality of background water in each aquifer that has not been affected by operations of the unit Monitor quality of water in each aquifer that has been affected by operations of the unit Use data to determine corrective actions	Monitor movement of GW contaminant distribution to determine if plume front is moving Determine if statistically significant evidence of contamination exists by the comparison of downgradient concentrations to upgradient concentrations in each aquifer Comparison to ground water performance standards[11] [10] Determine the extent of GW contamination Determine if karst system flow has changed
		• Alkalinity	Monitor karst geologic conditions to determine if karst-influenced GW flow conditions have changed	Reporting limit low enough to meet criteria for determining changes in karst-influenced GW flow conditions	Quarterly until 2 years after soil removal then semi-annual			
		• Slug testing [1] • Water level measurements	Determine GW flow rate and direction	Water levels within 0.01 feet	Quarterly until 2 years after soil removal then semi-annual			
	Laboratory	• Explosives[2][3] • Metals[2] (total and dissolved) • Cyanide • TCE and degradation products[5] • Phosphorous (total and dissolved)	Monitor waste constituents and reaction and degradation products that indicate the presence or absence of hazardous constituents in GW attributable to operations	Reporting limit low enough to meet GW protection standard in the permit[4] [10]	Quarterly until 2 years after soil removal then semi-annual			
		• VOCs[2] • SVOCs[2] • Pesticides/PCBs[2] • Herbicides[2] • Dioxins/Furans[2]	Monitor additional Appendix IX hazardous constituents to see if they have entered ground water[6]	Reporting limit low enough to meet ground water performance standard in the permit[4] [10]	Annually			
		• Sulfate • Dissolved Ca, Mg, Na and K • Chloride	Monitor karst geologic conditions to determine if karst-influenced GW flow conditions have changed	Reporting limit low enough to meet criteria for determining changes in karst-influenced GW flow conditions	Quarterly until 2 years after soil removal then semi-annual			
		• TOC • TOX • Nitrate	Monitor indicator parameters for presence of hazardous constituents	Reporting limit low enough to meet ground water performance standard in the permit[4] [10]	Quarterly until 2 years after soil removal then semi-annual.			

TABLE 1-1

SUMMARY OF RCRA GROUND WATER MONITORING REQUIREMENTS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Type of RCRA Program Sampling/Objective	Analytical Program (All Wells)				Frequency of Sampling	Monitoring Points		
	Parameter Type	Target Constituents	Objective	Limit of Detection		Location	Objective	Evaluations to be Performed
AMMUNITION BURNING GROUND (CONTINUED)								
Objective: • Monitor natural attenuation of existing GW contamination	Field:	• Dissolved oxygen (meter) • pH • Specific conductivity • Temperature • Turbidity • Oxidation Reduction Potential (ORP)	Determine if the well water is equivalent to formation water (i.e., stability)	Reporting limit low enough to meet criteria for determination of stability	Quarterly (2 years)	Natural attenuation: • Alluvium 03B02; 03B04 • Beech Creek 03C04; 03C10; 03C11; 03C12; 03C25 • Springs A and C • Little Sulfur Creek below spring A and at boundary	Demonstrate presence or absence of natural attenuation of TCE, explosives, and metals and if present the degradation pathways and rates	Determine if contaminated ground water is being naturally attenuated by the direct comparison of hazardous constituents and their degradation products over time
		• Carbon dioxide • Dissolved oxygen (test kit) • Ferrous iron • Hydrogen sulfide • Nitrite • Nitrate	Monitor parameters that are indicators of natural attenuation occurrence, pathways, and rates	Reporting limit low enough to meet concentration limits for determine natural attenuation occurrence, pathways and rates				
		• Water level measurements	Determine GW flow rates and directions	Water levels within 0.01 feet				
	Laboratory	• Explosives[2][7] (including degradation products) • VOCs[2] (TCE and degradation products[5]) • Metals[2] (total and dissolved	Monitor waste constituents and reaction products that are indicators of natural attenuation occurrence, pathways, and rates	Reporting limit low enough to meet the ground water protection standard in the permit[4] [10]				
		• Total iron • Dissolved Ca, Mg, and Mn • Chloride • Methane • Ethane • Ethene • Sulfate	Monitor indicator parameters used to evaluate degradation pathways	Reporting limit low enough to meet concentrations limits to determine natural attenuation occurrence, pathways, and rates				

TABLE 1-1

SUMMARY OF RCRA GROUND WATER MONITORING REQUIREMENTS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Type of RCRA Program Sampling/Objective	Analytical Program (All Wells)				Frequency of Sampling	Monitoring Points		
	Parameter Type	Target Constituents	Objective	Limit of Detection		Location	Objective	Evaluations to be Performed
OLD RIFLE RANGE (ORR)								
Type: RCRA Compliance Closure, Corrective Action Program and RCRA 3004(u) program Objectives: • Monitor GW for compliance with GW protection standards outlined in RCRA permit and listed in the approved-GW Monitoring Plan. • Establish background water quality for statistical comparisons • Monitor existing GW contaminant distribution (downgradient wells • Establish background water quality for statistical comparisons • Delineate the extent of GW contamination distribution (downgradient wells	Field	• Dissolved oxygen • pH • Specific conductivity • Temperature • Turbidity • Oxidation Reduction Potential (ORP)	Determine if the well water is equivalent to formation water (i.e., stability) Evaluate general water quality	Reporting limit low enough to meet criteria for determination of stability	Quarterly	Upgradient: • Big Clifty Upper 06C14P2 • Big Clifty/Beech Creek 06C08 Downgradient: • Big Clifty Upper 06C11P2; 06C13P2; 06C18P2 • Big Clifty/Beech Creek 06C11; 06C12; 06C13; 06C14; 06C15; 06C16; 06C18	Monitor quality of water in each interconnected aquifer underlying the unit Monitor quality of background water in each aquifer that has not been affected by operations of the unit Monitor quality of water in each aquifer that has been affected by operations of the unit Use data to determine any corrective actions	Determine if statistically significant evidence of contamination exists by the comparison of downgradient concentrations to upgradient concentrations in each aquifer Comparison to GW performance standards. Determine rate and extent of GW contaminant distribution
		• Water level measurements	Determine GW flow rate and direction	Water levels within 0.01 feet	Quarterly			
	Laboratory	• Explosives[2][8] • Ammonia • Metals[2] (total and dissolved) • Cyanide	Monitor waste constituents and reaction and degradation products that indicate the presence or absence of hazardous constituents in GW attributable to operations	Reporting limit low enough to meet the ground water protection standard in the permit[4] [10]	Quarterly			
		• VOCs[2] • SVOCs[2] • Pesticides/PCBs[2] • Herbicides[2] • Dioxins/Furans[2]	Monitor additional Appendix IX hazardous constituents to see if they have entered GW	Reporting limit low enough to meet the ground water protection standard in the permit[4] [10]	Annually			
		• TOC • TOX	Monitor indicator parameters for presence of hazardous constituents.	Reporting limit low enough to meet the ground water protection standard in the permit[4] [10]	Quarterly			

TABLE 1-1

SUMMARY OF RCRA GROUND WATER MONITORING REQUIREMENTS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Type of RCRA Program Sampling/Objective	Analytical Program (All Wells)				Frequency of Sampling	Monitoring Points		
	Parameter Type	Target Constituents	Objective	Limit of Detection		Location	Objective	Evaluations to be Performed
DEMOLITION RANGE (DR)								
Type: RCRA Detection monitoring Objectives: • Monitor indicator parameters that provide reliable indications of the presence or absence of hazardous waste and/or hazardous constituents (upgradient and downgradient wells) • Establish background GW quality	Field	• Dissolved oxygen • pH • Specific conductivity • Temperature • Turbidity • Oxidation Reduction Potential (ORP)	Determine if the well water is equivalent to formation water (i.e., stability) Evaluate general water quality	Reporting limit low enough to meet criteria for determination of stability	Semi-annual	Upgradient: • Pennsylvanian 06C08P2 • Big Clifty/Beech Creek 06C08 Downgradient: • Golconda/Haney LS 06C03P2; 06C04P2 • Pennsylvanian 06C06P2 • Lower Penn/Beech Creek 06C06 • Big Clifty/Beech Creek 06C02; 06C03; 06C04; 06C05 • Beech Creek LS 06C07	Monitor quality of water in each interconnected aquifer underlying the unit Monitor quality of background water in each aquifer that has not been affected by operations of the unit Monitor quality of GW in each aquifer that may be affected by operations of the unit	Determine if statistically significant evidence of contamination exists by the comparison of downgradient concentrations to upgradient concentrations in each aquifer. Comparison to GW performance standards
		• Water level measurements	Determine GW flow rate and direction	Water Levels within 0.01 feet	Semi-annual			
	Laboratory	• Explosives[2][3] • Metals[2] (total and dissolved) • Cyanide	Monitor waste constituents and reaction products that indicate the presence or absence of hazardous constituents in GW attributable to operations.	Reporting limit low enough to meet ground water protection standard in the permit[4] [10]	Semi-annual			
		• TOC • TOX	Monitor indicator parameters for hazardous constituents	Reporting limit low enough to meet ground water protection standard in the permit[4] [10]	Semi-annual			

TABLE 1-1

SUMMARY OF RCRA GROUND WATER MONITORING REQUIREMENTS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Type of RCRA Program Sampling/Objective	Analytical Program (All Wells)				Frequency of Sampling	Monitoring Points		
	Parameter Type	Target Constituents	Objective	Limit of Detection		Location	Objective	Evaluations to be Performed
OLD JEEP TRAIL								
Type: RFI Characterization Objectives: • Monitor GW for the presence or absence of hazardous constituents and determine concentrations if present (upgradient and downgradient wells) • Delineate the extent of the GW contaminant distribution (upgradient and downgradient wells) • Establish background water quality for statistical comparisons • Data support for risk assessment	Field	• Dissolved oxygen • pH • Specific conductivity • Temperature • Turbidity • Oxidation Reduction Potential (ORP)	Determine if the well water is equivalent to formation water (i.e., stability) Evaluate general water quality.	Reporting limit low enough to meet criteria for determination of stability	Quarterly[9]	TBD[11]	Monitor quality of water in each interconnected aquifer underlying the unit Monitor quality of background water in each aquifer that has not been affected by operations of the unit Monitor quality of water in each aquifer that may have been affected by operations of the unit Develop data for risk assessment Use data to determine corrective actions	Determine if statistically significant evidence of contamination exists by the comparison of downgradient concentrations to upgradient concentrations in each aquifer Determine the rate and extent of the GW contaminant distribution Determine if karst-influenced flows have changed
		• Alkalinity	Monitor karst geologic conditions to determine if karst-influenced GW flow conditions have changed	Reporting limit low enough to meet criteria for determining changes in karst-influenced GW flow				
		• Water levels measurements	Determine GW flow rate and directions	Water levels within 0.01 feet				
	Laboratory	• Explosives[2][3] • Metals[2] (total and dissolved) • Cyanide • VOCs • TCE and degradation products[5] • SVOCs[2] • VOCs[2] • Nitrate	Monitor waste constituents and reaction products that indicate the presence or absence of hazardous constituents in GW attributable to operations	Reporting limit low enough to meet the ground water protection standard in the permit[4] [10]	Quarterly[9]			
		• Sulfate • Dissolved Ca, Mg, Na and K • Chloride	Monitor karst geologic conditions to determine if karst-influenced GW flow conditions have changed	Reporting limit low enough to meet criteria for determining changes in karst-influenced GW flow	Quarterly[9]			

AWQC	Ambient Water Quality Criteria	MCLs	Maximum Contaminant Levels	RFI	RCRA Facility Investigation	TOC	Total organic carbon
DQLs	Data Quality Levels	NA	Not applicable	SVOCs	Semivolatile organic compounds	TOX	Total organic halides
GW	Ground water	PCBs	Polychlorinated biphenyls	TBD	To be determined	VOCs	Volatile organic compounds
IDEM	Indiana Department of Environmental Management	PRGs	Preliminary Remediation Goals	TCE	Trichloroethene	CMI	Corrective measures implementation

1 If data is not available, slug tests are to be performed during the first year.
2 See Table 1-3 for the list of specific chemicals and analytical methods.
3 Analyte list does not include picramic acid and picric acid.
4 Ground water protection standards consists of human health- and ecological-based criteria consist of U.S. EPA DQLs for human health and ecological receptors, U.S. EPA Region IX PRGs for drinking water; U.S. EPA Eco Tox Thresholds; Safe Drinking Water Act MCLs; IDEM health-based criteria; and Federal and state AWQC.
5 Primary chlorinated degradation products for trichloroethene include trans-dichloroethene, cis-dichloroethene, 1,1-dichlorethylene, and vinyl chloride.
6 Analyses will be performed once during the first year of monitoring, unless detections are observed.
7 Analyte list includes 2,4-diamino-6-nitrotoluene, 2,6-diamino-4-nitrotoluene, 2,2',6,6-tetranitro-4,4'-azoxytoluene, 3,5-dinitroaniline, 1,3,5-trinitroso-1,3,5-hexahydrotriazine, 1-nitroso-3,5-dinitro-1,3,5-hexahydrotriazine, and picric acid.
8 Analyte list includes picramic acid and picric acid.
9 Four quarters of sampling to be conducted with additional sampling to be conducted based on the results of the quarterly monitoring.
10 The ground water protection standards are identified in the operating permit for the ABG, ORR, and DR.
11 Monitoring well network to be determined following additional investigations.

Table 1-1 identifies the evaluations to be performed to fulfill the overall objectives of the project. Direct comparisons of upgradient and downgradient well concentrations to human health- and ecological-based criteria, as well as direct comparisons of increases in downgradient over upgradient well concentrations to human health- and ecological-based criteria, will be performed to assess the potential impacts to human and ecological receptors. Statistical comparisons between upgradient and downgradient well concentrations will be performed in accordance with the statistical evaluation procedures described in Section 10.0 of the Ground Water Monitoring Plan. Separate statistical evaluations will be conducted for each of the units and for each aquifer monitored. Information contained in the reports will be as described in the approved Ground Water Monitoring Plan, Section 10.4. Historical data determined to be acceptable by U.S. EPA Region 5 following various data reviews have been used to evaluate whether hazardous constituents have entered the ground water. A summary of the usable, historical data sets for each unit is provided in Table 1-2.

Additional discussions regarding project objectives for ground water monitoring at NSWC Crane are provided in Section 1.4 of this QAPP.

1.1.2 Project Status/Phase

The RCRA ground water monitoring program (which includes surface water sampling) at NSWC Crane will use an integrated and phased approach. During the implementation phase, data collection activities will be conducted in accordance with the frequency described in the RCRA Part B permit for each of the three operating units (ABG, ORR, and DR), including the closing units (waste pile and surface impoundments) associated with past operations. The RCRA permit has established the type of RCRA ground water monitoring program (detection or compliance/corrective action) to be performed at each unit and the types of analyses to be conducted. For the purpose of this ground water program, the U.S. EPA has designated the "operating unit" or "Facility" as the area circumscribing many individual burning or individual detonating units or structures. Points of compliance are established based on this.

Table 1-1 provides a summary of the RCRA ground water monitoring requirements, as described in the NSWC Crane RCRA permit. Ground water and surface water samples will be analyzed for chemical and physical parameters. The general list of analytical parameters for ground water monitoring was developed based on the project-specific objectives (Section 1.4), as well as the results of previous Appendix IX ground water monitoring performed for each unit. The monitoring wells, spring and surface water locations, and analytical parameters to be included in the Ground Water Monitoring Program for each of the three units were identified and agreed upon by the U.S. EPA Region 5 and NSWC Crane,

TABLE 1-2

SUMMARY OF USABLE HISTORICAL DATA SETS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 2

Monitoring Well	Usable Chemical Fractions According to Date of Collection								
	08/97[1]	09/95[2]	08/93[2]	07/93[2]	04/92[2]	11/91[2]	06/91[2]	03/91[2]	11/90[2]
AMMUNITION BURNING GROUNDS									
03B02			E,M,C,P,S,V,W						
03B04									
03C02P2			E,M,C,P,S,V,W						
03C03			E,M,C,P,S,V,W						
03C04			E,M,C,P,S,V,W						
03C07			E,M,C,P,S,V,W						
03C08P2			E,M,C,P,S,V,W						
03C09P2			E,M,C,P,S,V,W						
03C10			E,M,C,P,S,V,W						
03C11			E,M,C,P,S,V,W						
03C12			E,M,C,P,S,V,W						
03C15	E		E,M,C,P,S,V,W						
03C17		E,M,S,V,W	E,M,C,P,S,V,W						
03C20	E,V		E,M,C,P,S,V,W						
03C25			E,M,C,P,S,V,W						
03C26			E,M,C,P,S,V,W						
03C27			E,M,C,P,S,V,W						
03C30			E,M,C,P,S,V,W						
Spring A		E,M,S,V,W	E,M,C,P,S,V,W						
Spring C		E,M,S,V,W	E,M,C,P,S,V,W						
OLD RIFLE RANGE									
06C08				E,M,C,P,S,V,W		E	E		E
06C11				E,M,C,P,S,V,W	E	E	E	E	
06C11P2				E,M,C,P,S,V,W	E	E	E	E	
06C12		E,M,S,V,W		E,M,C,P,S,V,W	E	E	E	E	
06C13				E,M,C,P,S,V,W	E	E	E		E
06C13P2				E,M,C,P,S,V,W	E	E	E		E
06C14				E,M,C,P,S,V,W	E	E	E		E
06C14P2				E,M,C,P,S,V,W	E	E	E		E
06C15				E,M,C,P,S,V,W	E	E	E		E
06C16		E,M,S,V,W		E,M,C,P,S,V,W	E	E	E		E
06C18		E,M,S,V,W		E,M,C,P,S,V,W	E	E	E		E
06C18P2		E,M,S,V,W		E,M,C,P,S,V,W	E	E	E		E

TABLE 1-2

SUMMARY OF USABLE HISTORICAL DATA SETS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 2

Monitoring Well	Usable Chemical Fractions According to Date of Collection								
	08/97[1]	09/95[2]	08/93[2]	07/93[2]	04/92[2]	11/91[2]	06/91[2]	03/91[2]	11/90[2]
DEMOLITION RANGE									
06C02				E,M,C,P,S,V,W		E	E	E	
06C03		E,M,S,V,W		E,M,C,P,S,V,W		E	E	E	
06C03P2		E,M,S,V,W		E,M,C,P,S,V,W		E	E	E	
06C04				E,M,C,P,S,V,W		E	E	E	
06C04P2		E,M,S,V,W		E,M,C,P,S,V,W		E	E	E	
06C05				E,M,C,P,S,V,W		E	E	E	
06C06		E,M,S,V,W		E,M,C,P,S,V,W		E	E	E	
06C06P2		E,M,S,V,W		E,M,C,P,S,V,W		E	E	E	
06C07		E,M,S,V,W		E,M,C,P,S,V,W		E	E	E	
06C08				E,M,C,P,S,V,W		E	E		E
06C08P2		E,M,S,V,W		E,M,C,P,S,V,W		E	E		E

E Explosives.
M Inorganics.
C PCBs.
P Pesticides.
S Semivolatiles.
V Volatiles.
W Water quality parameters.

1 Confirmation samples collected by the TtNUS Team (Rust Environment and Infrastructure, July 1997). Analytical data is assumed to be usable.
2 The data has been identified as usable by U.S. EPA Region 5 following a detailed review of select data sets.

during several project scoping meetings. As identified previously, the ground water monitoring well network for the OJT will be determined at a later date following additional corrective action investigation activities and amended to this plan.

The results of the sampling, direct comparisons, and statistical evaluations will be used to determine subsequent actions and compliance. These actions may include modification of the parameter list for future monitoring and switching among RCRA detection, compliance, and corrective action ground water monitoring programs.

1.1.3 QAPP Preparation Guidelines

As identified previously, this QAPP has been prepared in accordance with the "Region 5 Model RCRA Quality Assurance Project Plan" (U.S. EPA Region 5, May 1993) and reviewed in accordance with the U.S. EPA "Region 5 QAPP Policy" (U.S. EPA Region 5, April 1998). Additional guidance regarding the generation of the QAPP was obtained during various project scoping meetings. One of these meetings was a formal "pre-QAPP" meeting, which was held on May 21, 1997, at U.S. EPA Region 5 headquarters in Chicago, Illinois. Representatives of the U.S. EPA Region 5; IDEM; United States Navy Southern Division Naval Facilities Engineering Command; NSWC Crane; and TtNUS attended this meeting. Another meeting, which included representatives of the U.S. EPA Region 5; United States Navy Southern Division Naval Facilities Engineering Command; NSWC Crane; Laucks Testing Laboratories, Inc.; and TtNUS, was held on December 30, 1997, at U.S. EPA Region 5 headquarters to discuss U.S. EPA Region 5 comments on the draft version of this QAPP.

1.2 SITE/FACILITY DESCRIPTION

A brief description of NSWC Crane with respect to the ABG, ORR, and DR, its geological setting, and associated features is presented in this section. Additional details can be found in Section 2.0 of the approved FSP; specific sub-sections and Figures of the approved FSP are referenced as appropriate.

1.2.1 Location

NSWC Crane is located in southwestern Indiana approximately 75 miles southwest of Indianapolis and 71 miles northwest of Louisville, Kentucky (Figure 2-1 of the approved FSP). NSWC Crane occupies 62,463 acres (approximately 100 square miles) of the northern portion of Martin County and small portions of neighboring Greene, Davies, and Lawrence Counties.

Figure 2-2 of the approved FSP shows the locations of the ABG, ORR, and DR. The ABG lies in the eastern part of NSWC Crane. The ABG is located in the northwest corner of Section 28 and the southwest corner of Section 21, Township 5N, Range 3W of the Indiana Springs, Indiana, topographic quadrangle.

The ORR is located immediately northeast of the DR. The Old Rifle Range is immediately west of NSWC Crane Highway 8 in the flat-lying floodplain of Turkey Creek, immediately downslope of the DR. The ORR is located in Sections 26 and 35 of Township 5N, Range 4W on the Indian Springs, Indiana, topographic quadrangle.

The DR is in the central portion of NSWC Crane east of NSWC Crane Highway 45 and south of NSWC Crane Highway 58. The restricted zone for the DR occupies approximately 1250 acres of Sections 26, 27, 34, and 35 of Township 5N, Range 4W of the Indian Springs, Indiana, topographic quadrangle.

1.2.2 Facility Size and Borders

The ABG consists of about 50 acres. The ABG is approximately 2,000 feet long by 1,000 feet wide and is situated in the southern reaches of the valley of Little Sulphur Creek. The ABG is surrounded by forested area on all sides. Figure 2-3 of the approved FSP shows the layout of the ABG, including the various treatment units.

The ORR occupies approximately 20 acres (10 active) within the restricted zone of the DR. Figure 2-4 of the approved FSP shows the layout of the ORR, including the treatment units.

The DR occupies roughly 90 acres atop a topographic ridge. The DR is bounded on the west, south, and east by major surface streams, Boggs Creek, and Turkey Creek. Figure 9-1 of the approved Ground Water Monitoring Plan shows the layout of the DR, including the Navy and Army ranges.

1.2.3 Natural and Manmade Features

Natural and manmade features are addressed in Section 2.2 of the approved FSP.

1.2.4 Topography

See Section 2.2 of the approved FSP for information concerning the general topography of the units.

1.2.5 Local Hydrology and Hydrogeology

See Sections 2.4 and 2.6 of the approved FSP for information on local hydrology and hydrogeology, respectively. Section 2.5 of the approved FSP provides information on local geology and stratigraphy.

1.3 FACILITY HISTORY

This section contains a brief summary of the general history of NSWC Crane and specific, brief histories for each unit.

1.3.1 General History

The facility was opened in 1941 as the Naval Ammunition Depot, Burns City, to serve as an inland munitions production and storage center. The name was changed in 1975 to the Naval Weapons Support Center and in 1992 to NSWC Crane. The Department of Defense (DOD) ammunition procurement responsibility was transferred to the Army in 1977. The Army has assumed ordnance production, storage, and related responsibilities under the single service management directive. All environmental activities on the installation, including permitting activities, remain the responsibility of the Navy.

1.3.1.1 Ammunition Burning Grounds

The ABG has been used extensively since the 1940s for the open burning of materials contaminated with explosives, bulk explosives and propellants, rocket motors, candles, flares, explosives-contaminated solvents, red phosphorus, and small munitions and components, such as detonators and fuses. As of 1994, the largest quantities in terms of net explosive weight (NEW) were destroyed between 1956 and 1960, when 15,000 pounds per day of smokeless powder and 48,000 pounds per day of high explosives (H-6 and Composition B) were burned. The ABG is also used for flashing (burning) of the residue from bombs and projectiles after they have been subjected to melt-out or drill-out operations to remove explosives.

1.3.1.2 Old Rifle Range

The ORR acquired its name when it served as the Marine rifle range. The ORR was first used for the destruction of explosives by open burning and open detonation in the 1940s and was also used for bomb "cook-off" tests. Current operations consist of open burning of the explosive "Yellow-D" (ammonium picrate and 2,4,6-trinitrophenol ammonium salt) in bulk and in loaded projectiles in three burning pits.

Projectiles that contain "Yellow D" are also flashed. Prior to 1986 the burning of projectiles was conducted on bare ground. Burning of projectiles now takes place on clay-lined, concrete pads. Between 1981 and 1995, burning of bulk Yellow-D took place in burn pans on top of clay and synthetic-lined depressions. Bulk Yellow-D is now burned on clay-lined steel pans which are placed on blocks and then placed on clay-lined concrete pads.

1.3.1.3 Demolition Range

Explosives/munitions have been treated by detonation at the DR since the 1940s. Explosives treated include RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine), TNT (2,4,6-trinitrotoluene), and HMX (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine). Explosives/munitions, which are prepared by packing them in drums, are placed in trenches excavated in the bare ground along with donor material, covered with soil, and detonated. As of 1995, as much as 10 tons per day NEW had been disposed of at the DR from 1956 to 1960. Currently, approximately 35 to 70 shots per day are fired. The NEW limit per detonation is 500 pounds. Unexploded ordnance (UXO) has occasionally been found on site.

1.3.2 Past Data Collection Activities

This section includes a brief description of the historical data collection activities conducted at the ABG, ORR, and DR. The following summary has been generated using reports and supporting documents (submitted by other contractors) provided by NSWC Crane.

The ABG, ORR, and DR have been subject to a number of investigations, which began in 1981. The first investigation, which included all three units, was the Initial Assessment Study (IAS) (NEESA, May 1983). The IAS began in April 1981 in response to the Navy Assessment and Control of Installation Pollutants (NACIP) Program and was completed in May 1983 by the Naval Energy and Environmental Support Agency (NEESA) with assistance from the Ordnance Environmental Support Agency and the United States Army Corps of Engineers (U.S. ACE) Waterways Experiment Station (WES). The intent of the IAS was to identify and assess sites posing a potential threat to human health and the environment from past hazardous materials operations. Although none of the sites investigated were determined to represent immediate human health and environmental threats, 14 of the sites were recommended for further study to evaluate potential long-term impacts. The ABG, ORR, and DR were among the 14 sites recommended for further investigation.

A summary of the post-IAS data collection activities for ground water at each of the three units is provided in the remainder of this subsection. Although various soils investigations have been performed by

contractors at the ABG, ORR, and DR, a summary of these studies is not included because the QAPP addresses only ground water monitoring activities.

1.3.2.1 Ammunition Burning Grounds

A total of 98 monitoring wells were installed at the ABG by the U.S. ACE between 1981 and 1992 as part of various investigations, including a Confirmation Study and RCRA Facility Investigations (RFIs). Monitoring wells at the unit are screened at various depths, comprising three water-bearing units (i.e., the Beaver Bend limestone, Big Clifty sandstone and Beech Creek limestone, and Golconda/Haney limestone aquifers).

Since 1987, ground water monitoring has been conducted for 72 monitoring wells at the ABG. Additional ground water samples were collected by the TtNUS team (specifically, Rust Environment & Infrastructure, Inc.) from 1995 to 1997 as part of risk assessment activities. Seven springs near the ABG have also been sampled on occasion. Ground water samples collected during quarterly monitoring activities were analyzed for select constituents, which primarily consisted of explosives, organics, and certain inorganics. Ground water samples collected during 1995 to 1997 have typically been analyzed for most Appendix IX constituents and explosives (Murphy, May 1994) to establish background and plume constituents.

1.3.2.2 Old Rifle Range

Ten ground water monitoring wells were installed at the ORR from 1981 to 1983 by the U.S. ACE during a Confirmation Study to confirm the potential impacts to human health and the environment identified in the IAS. A total of 11 additional monitoring well clusters were installed by the U.S. ACE WES in 1990 (19 wells) and 1994 (2 wells) as part of a Phase I RFI. Monitoring wells at the unit are screened at various depths, comprising three water-bearing units (i.e., the alluvium and Big Clifty sandstone, Big Clifty sandstone and Beech Creek limestone, and Golconda/Haney limestone aquifers).

Quarterly ground water monitoring was conducted at the ORR from 1981 to 1983. Semi-annual sampling began in 1984. Additional ground water samples were collected by the U.S. ACE WES from 1989 to 1992 as part of the RFI Phase II Release Assessment for Ground Water (Murphy, November 1995) and by the TtNUS team (specifically, Rust Environment & Infrastructure, Inc.) from 1995 to 1997 as part of risk assessment activities. Ground water samples collected during quarterly and semi-annual monitoring activities were analyzed for select constituents, which primarily consisted of explosives and certain inorganics. Ground water samples collected since the 1990s have typically been analyzed for most Appendix IX constituents and explosives to establish background and plume constituents.

1.3.2.3 Demolition Range

During a Confirmation Study for the DR, the U.S. ACE WES installed 17 monitoring wells in 1981 to confirm the potential impacts to human health and the environment identified in the IAS. Nine of the 17 monitoring wells installed at that time have been destroyed as a result of site operations. Fifteen additional monitoring wells have been installed at the unit since 1989 by the U.S. ACE as part of RFI activities. Monitoring wells at the unit are screened at various depths, comprising four water-bearing units (i.e., the alluvium and Big Clifty sandstone, Big Clifty sandstone and Beech Creek limestone, Golconda/Haney limestone, and Pennsylvanian aged sandstone aquifers).

Quarterly ground water monitoring was conducted at the DR from 1981 to 1983. Semi-annual sampling began in 1984. Additional ground water samples were collected by the U.S. ACE WES from 1989 to 1992 as part of the RFI Phase II Release Assessment for Ground Water (Murphy, November 1995) and by the TtNUS team (specifically, Rust Environment & Infrastructure, Inc.) from 1995 to 1997 as part of risk assessment activities. Ground water samples collected during quarterly and semi-annual monitoring activities were analyzed for select constituents, which primarily consisted of explosives and certain inorganics. Ground water samples collected since the 1990s have typically been analyzed for most Appendix IX constituents and explosives to establish background and confirm the absence of a plume.

1.3.3 Current Status

Based on the reports and documents reviewed for the ABG, ORR, and DR and a current assessment of all available information, the following target compounds and source area release mechanisms have been targeted for ground water monitoring:

Ammunition Burning Grounds (including surface impoundments and waste pile)

The ABG has treated ammunition and explosives-contaminated wastes by open burning since the early 1940s. Materials handled at the unit include propellants, bulk explosives, rocket motors, candles, flares, solvents, red phosphorus, small detonators, and fuse material. Three closed surface impoundments existed at the unit for the purpose of removing liquids from sludges generated during the blending and loading of munitions. The impoundments were unlined and uncovered prior to 1982. In 1982 clay liners were installed. In 1991, closure began with physical removal of the impoundments, including the clay liners. An ash pile, which was removed from the unit between 1986 and 1987, was used at the site for the collection of burn residue from operations. Past treatment and disposal operations have contaminated ground water beneath the unit with various chemicals, including explosives (TNT, RDX, and

HMX), metals, volatile organics (trichloroethene and 1,1,1-trichloroethane), and nitrates. A review of the results of past ground water data collection activities has indicated that these chemicals have been detected in the ground water at the ABG.

Old Rifle Range

Open burning and open detonation activities at the ORR began in the 1940s, when the unit was used for bomb "cook-off" tests. Current operations consist of the open burning or "flashing" of the explosive "Yellow-D" (ammonium picrate and 2,4,6-trinitrophenol ammonium salt) in bulk and in loaded projectiles. Current operations at the unit take place on three clay-lined, concrete pads. Burning of projectiles takes place directly on the pads. Bulk Yellow-D is burned on clay-lined steel pans which are placed on blocks and then placed on the clay-lined concrete pads. Prior to 1986, the burning was conducted on bare ground. Past treatment and disposal operations at the ORR have contaminated ground water beneath the unit with various explosives (HMX, RDX, and TNT) and metals. No verifiable concentrations of volatile or semivolatile organics, pesticides, or polychlorinated biphenyls (PCBs) have been detected in the ground water at the unit (Murphy, November 1995).

Demolition Range

Since the 1940s, high explosives have been disposed of at the DR by detonation. Currently, all routine operations involve the detonation of prepared, drummed explosives/munitions. The DR is also used for emergency treatment of explosives. Located next to the DR is the Navy Explosives Ordnance Disposal (EOD) range used by the Navy EOD Detachment (see Figure 2-5 of the approved FSP). Explosives products handled at the unit include RDX, TNT, and HMX. The blast zone at the unit has been cleared of vegetation, creating enhanced surface runoff. Four NPDES-regulated sedimentation ponds located downslope of the demolition area intercept the runoff. Past detonation activities may have contaminated ground water underlying the unit. Although no explosives have been detected in the ground water during previous monitoring activities, certain metals have been detected in ground water samples collected from wells located inside the boundary of the DR. However, no metals have been detected in the ground water samples collected from the Point of Compliance wells. No verifiable concentrations of volatile or semivolatile organics, pesticides, or PCBs have been detected in the ground water at the unit (Murphy, November 1995).

Old Jeep Trail

An area approximately one-half mile south of the ABG, referred to as the OJT, was used from early 1980 to 1983 to burn out bombs and to flash powder.

1.4 PROJECT OBJECTIVES

This section provides a detailed discussion of the project objectives for ground water monitoring at NSWC Crane. Specific objectives and associated tasks are discussed in Section 1.4.1. Project target parameters and intended data uses are provided in Section 1.4.2. Data Quality Objectives (DQOs), which are qualitative and quantitative statements specifying the quality of the analytical data required to support decisions to be made under the RCRA Part B permit, are presented in Section 1.4.3.

1.4.1 Specific Objectives and Associated Tasks

For this project, it will be necessary to gather sufficient information to evaluate whether the operation of the DR is resulting in the release of hazardous constituents to the ground water at concentrations which may adversely affect human health and the environment and to evaluate the delineation and containment of releases of hazardous constituents of the ABG and ORR. In addition, evaluations of natural attenuation of ground water contamination, Karst system behavior, and plume movement will take place at the ABG. The specific objectives of data collection for RCRA ground water monitoring at each of the units are presented in Table 1-1.

To accomplish these goals, a confirmation level of analytical quality is needed. This provides the highest level of data quality necessary to address human and ecological risks. These analyses require full documentation of the chosen U.S. EPA SW-846 and custom analytical methods and sample preparation steps, data packages, and data validation sufficient to provide defensible data. QC must be sufficient to define the precision and accuracy of these procedures at every step.

1.4.2 Project Target Parameters and Intended Data Usages

The list of target parameters is included in Table 1-3. Field measurements and laboratory data will be obtained for each of the units to meet the project objectives outlined in Table 1-1. The columns under the heading "Analytical Program (All Wells)" on Table 1-1 define the specific data usages for each of the analytical parameters. Further details regarding the specific sampling and analytical programs for the ABG, ORR, and DR are provided in Tables 4-1 through 4-9 of the approved FSP. Laboratory data will be compared to human health- and ecological-based criteria with the ultimate objective of determining whether hazardous constituents are present in the ground water at concentrations which may adversely affect human health and the environment. Statistical evaluations of the laboratory data will be performed

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
EXPLOSIVES (SW-846 METHOD 8330)			
1,3,5-Trinitrobenzene	0.41	1.0	1.8
1,3-Dinitrobenzene	0.41	0.9	2.36
2,4,6-Trinitrotoluene (TNT)	0.57	1.6	2.2
2,4-Dinitrotoluene	0.57	1.2	60.8
2,6-Dinitrotoluene	0.83	2.0	37
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	0.38	2.0	1800
2-Nitrotoluene	0.48	2.0	2.2
3-Nitrotoluene	0.48	2.0	370
4-Nitrotoluene	0.48	2.0	370
4-Amino-2,6-dinitrotoluene	0.35	1.6	--[3]
2-Amino-4,6-dinitrotoluene	0.34	0.9	--
Methyl-2,4,6-trinitrophenylnitramine (Tetryl)	0.29	1.2	370
Nitrobenzene	0.22	1.5	15.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	0.35	0.61[4]	0.61
Nitroglycerin	1.7	13	--
Pentaerythritol tetranitrate (PETN)	2.4	26	--
2,4-Diamino-6-nitrotoluene	0.39	10	--
2,6-Diamino-4-nitrotoluene	0.35	10	--
2,2',6,6'-Tetranitro-4,4'-azoxytoluene (4,4'-TN-AZOXY)	0.48	10	--
3,5-Dinitroaniline	0.39	10	--
1,3,5-Trinitroso-1,3,5-hexahydrotriazine (TNX)	0.21	10	--
1-Nitroso-3,5-dinitro-1,3,5-hexahydrotriazine (MNX)	0.36	10	--
EXPLOSIVES (MODIFIED ARMY CORPS METHOD)			
Nitrocellulose	114	1000	--
EXPLOSIVES (LAUCKS HPLC METHOD)			
Picric acid	0.06	1.0	--
Picramic acid	0.18	0.9	--
APPENDIX IX METALS (SW-846 METHOD 6020 ICP/MS, UNLESS OTHERWISE NOTED)			
Antimony	1.0	1.0	6
Arsenic	1.0	1.0	2
Barium	0.5	1.0	3.9
Beryllium	0.5	1.0	4
Cadmium	0.5	1.0	1.1
Chromium (total)	0.5	5.0	10
Cobalt	0.5	3.0	3
Copper	0.5	2.0	11
Lead	0.5	1.0	2.5
Mercury (SW-846 Method 7470A)	0.06	0.2	1.3
Nickel	0.5	10	100
Selenium	1.0	1.0	5
Silver	0.5	3.0	4.1
Tin	0.1	10	73
Thallium	0.5	1.0	2
Vanadium	0.5	2.0	19
Zinc	5.0	10	100

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
ADDITIONAL METALS (SW-846 METHOD 6010B ICP/AES)			
Calcium	112	1000	--
Iron	16	100	300
Magnesium	33	1000	--
Manganese	1.5	15	50
Potassium	147	1000	--
Sodium	28	1000	--
APPENDIX IX VOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8260B WITH 25 ML PURGE)			
1,1,1-Trichloroethane	0.17	0.5	88
1,1,1,2-Tetrachloroethane	0.13	0.5	5
1,1,2,2-Tetrachloroethane	0.10	0.5	5
1,1,2-Trichloroethane	0.14	0.5	5
1,2,3-Trichloropropane	0.54	1[4]	12.11
1,2,3-Trichlorobenzene	0.08	0.5	--
1,1-Dichloroethane	0.17	0.5	47
1,1-Dichloroethene	0.12	0.5	0.5
1,1-Dichloropropylene	0.15	0.5	--
1,2-Dibromo-3-chloropropane	0.30	1	1
1,2-Dibromoethane	0.13	0.5	1
1,2-Dichloroethane	0.14	0.5	1
1,2-Dichloropropane	0.14	0.5	380
1,3-Dichloropropane	0.15	0.5	--
2,2-Dichloropropane	0.18	0.5	--
2-Butanone	0.86	10	917.72
2-Chloro-1,3-butadiene (chloroprene)	0.40	3	14
2-Hexanone	0.92	10	--
4-Methyl-2-pentanone	0.52	10	1520
Acetone	1.8	10	610
Acrolein	4.6	10*	4
Acrylonitrile	1.3	3	3.7
Allyl chloride (3-chloro-1-propene)	0.22	10	1800
Benzene	0.013	0.5	5
Bromochloromethane	0.18	0.5	--
Bromodichloromethane	0.13	0.5	100
Bromoform	0.18	0.5	8.5
Bromomethane	0.59	1[4]	8.7
Carbon disulfide	0.13	0.5	21
Carbon tetrachloride	0.17	0.3[4]*	0.17
Chlorobenzene	0.18	0.5	10
Chloroethane	0.21	0.5	710
Chloroform	0.14	0.3*	0.16
Chloromethane	0.17	0.5	1.5
cis-1,2-Dichloroethene	0.10	0.5	61
cis-1,3-Dichloropropene	0.16	0.3[4]*	0.081
Dibromochloromethane	0.10	0.5	1
Dibromomethane	0.19	0.5	370
Dichlorodifluoromethane	0.18	0.5	390
Ethylbenzene	0.076	0.5	17.2

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 3 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
Ethyl methacrylate	0.31	1	550
Methacrylonitrile	0.15	1	1
Methylene chloride	0.19	3	4.3
Methyl iodide	0.28	0.5	--
Methyl methacrylate	0.29	2	2800
Styrene	0.10	0.5	56
Tetrachloroethene	0.16	0.5	1.1
Toluene	0.04	0.5	253
trans-1,2-Dichloroethene	0.10	0.5	100
trans-1,3-Dichloropropene	0.10	0.5	0.5
trans-1,4-Dichloro-2-butene	0.34	10	10
Trichloroethene	0.12	0.5	1.6
Trichlorofluoromethane	0.14	0.5	1300
Vinyl acetate	0.21	0.5	248.03
Vinyl chloride	0.20	0.5	2
Total Xylenes	0.18	1	1.8
APPENDIX IX VOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8015B WITH 10 ML PURGE)			
1,4-Dioxane (SW-846 Method 8015B)	66	500*	2
Acetonitrile (SW-846 Method 8015B)	7.6	40	220
Isobutyl alcohol (SW-846 Method 8015B)	3.4	40	11000
Propionitrile (SW-846 Method 8015B)	2.9	40	6080
APPENDIX IX SEMIVOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8270C; 8270C SIM WHERE NOTED)			
1,2,4,5-Tetrachlorobenzene	2.7	10	10
1,2,4-Trichlorobenzene	0.43	2	70
1,2-Dichlorobenzene	0.74	2	14
1,3-Dichlorobenzene	0.68	2	71
1,4-Dichlorobenzene	0.65	2	5
1,4-Naphthoquinone	3.7	10	10
1,4-Phenylenediamine	25	100	6900
1-Naphthylamine	18	36*	10
2,3,4,6-Tetrachlorophenol	12	25*	14.06
2,4,5-Trichlorophenol	2.1	5	63
2,4,6-Trichlorophenol	0.89	3*	2
2,4-Dichlorophenol	1.49	3	18
2,4-Dimethylphenol	1.44	5	166.9
2,4-Dinitrophenol	0.12	10	10
2,6-Dichlorophenol	5.4	5	--
2-Acetylaminofluorene	4.2	12	14.86
2-Chloronaphthalene	0.60	2*	1
2-Chlorophenol	1.4	3*	2
2-Methylnaphthalene by SIM	0.019	0.04	9.15
2-Methylphenol	0.36	2	1520
2-Naphthylamine	5.2	16	--
2-Nitroaniline	0.60	2	2.2
2-Nitrophenol	1.1	5	13.5
2-Picoline	9.2	20	3790
3,3'-Dichlorobenzidine	0.59	10	10
3,3'-Dimethylbenzidine	25	50*	10
3-Methylcholanthrene	3.9	12	400

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 4 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
3-, 4-Methylphenol[5]	0.70	4	1800
3-Nitroaniline	0.54	2	--
4,6-Dinitro-2-methylphenol	0.31	10	10
4-Aminobiphenyl	3.4	12	--
4-Bromophenyl phenyl ether	0.31	2	2
4-Chloro-3-methylphenol	0.66	2	34.79
4-Chloroaniline	0.60	2	121.6
4-Chlorophenyl phenyl ether	0.24	1	1
4-Nitroaniline	0.87	2	--
4-Nitrophenol	0.24	10	35
4-Nitroquinoline-1-oxide	11	100	--
5-Nitro-o-toluidine	8.0	16	--
7,12-Dimethylbenz(a)anthracene	7.0	10[4]	10
Acenaphthene by SIM	0.008	0.02	23
Acenaphthylene by SIM	0.011	0.04	1
Acetophenone	3.3	20	687.89
Aniline	0.52	5	5
Aramite	4.0	10	10
Anthracene by SIM	0.018	0.04	5
Benzo(a)anthracene by SIM	0.014	0.04	1
Benzo(a)pyrene by SIM	0.015	0.04	1
Benzo(b)fluoranthene by SIM	0.016	0.04	1
Benzo(g,h,i)perylene by SIM	0.014	0.04	1
Benzo(k)fluoranthene by SIM	0.018	0.04	1
Benzyl alcohol	0.62	10	281.24
Bis(2-chloroethoxy)methane	1.0	5	6400
Bis(2-chloroethyl)ether	0.58	1[4]	1
Bis(2-chloroisopropyl)ether	0.29	3	3
Bis(2-ethylhexyl)phthalate	0.46	2	4.8
Butyl benzyl phthalate	0.58	2	19
Chlorobenzilate	3.4	5[4]*	2.5
Chrysene by SIM	0.015	0.04	1
Diallate	3.5	10	10
Di-n-butyl phthalate	0.28	2	3
Di-n-octyl phthalate	0.67	2	30
Dibenzo(a,h)anthracene by SIM	0.012	0.04	1
Dibenzofuran	0.29	1	13.52
Diethyl phthalate	0.55	2	220
Dimethoate	5.4	10[4]	10
p-(Dimethylamino)azobenzene	3.7	15	--
a,a-Dimethylphenethylamine	17	50	--
Dimethyl phthalate	0.28	2	73
Diphenylamine[6]	3.6	10	10
Disulfoton	8.54	16[4]*	0.3
Ethyl methane sulfonate	4.80	16	--
Ethyl parathion	5.23	15	--

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 5 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
Famphur	2.60	10	--
Fluoranthene by SIM	0.014	0.04	8.1
Fluorene by SIM	0.015	0.04	10
Hexachlorobenzene	0.30	2	2
Hexachlorobutadiene	0.63	1[4]	1
Hexachlorocyclopentadiene	0.05	2	2
Hexachloroethane	0.71	2	4.8
Hexachloropropene	4.0	20	20
Indeno(1,2,3-cd)pyrene by SIM	0.008	0.02	1
Isodrin	3.4	10	10
Isophorone	0.48	1	71
Isosafrole	2.9	20	--
Kepone	6.2	25*	0.7
Methapyrilene	17	40	--
Methyl methane sulfonate	4.1	16	--
Methyl parathion	4.98	10*	9.1
n-Nitrosodi-n-butylamine	4.7	10	10
n-Nitrosodiethylamine	3.3	10	10
n-Nitrosodimethylamine	0.44	10	10
n-Nitrosodi-n-propylamine	0.39	2	2
n-Nitrosomethylethylamine	3.6	10	10
n-Nitrosomorpholine	5.3	10[4]	10
n-Nitrosopiperidine	3.6	10	10
n-Nitrosopyrrolidine	3.0	10	10
Naphthalene by SIM	0.014	0.04	24
Pentachlorobenzene	4.7	10	10
Pentachloroethane	4.8	10	14.39
Pentachloronitrobenzene	3.8	10	10
Pentachlorophenol	0.97	10	10
Phenacetin	1.6	10	10
Phenanthrene by SIM	0.019	0.04	1
Phenol	1.5	5	100
Phorate	5.06	10[4]*	3.62
Pronamide	3.3	12	160
Pyrene by SIM	0.017	0.04	1
Pyridine	1.2	10	37
Safrole	2.7	20	40
Tetraethyl dithiopyrophosphate (Sulfotepp)	3.5	10	10
Thionazin	4.0	100	--
o-Toluidine	5.2	15	--
O,O,O-Triethyl phosphorothioate	4.6	10	10
APPENDIX IX ORGANOCHLORINE PESTICIDES and PCBs (SW-846 METHOD 8081)			
Aldrin	0.0028	0.01	0.01
Alpha-BHC	0.0031	0.01	0.01
Alpha-chlordane	0.0020	0.03	0.03
Beta-BHC	0.0024	0.03	0.037
4,4'-DDD	0.0035	0.05	0.05
4,4'-DDE	0.0029	0.05*	0.01

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 6 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
4,4'-DDT	0.0048	0.05*	0.01
Delta-BHC	0.0020	0.05	666.67
Dieldrin	0.0060	0.02	0.02
Endosulfan I	0.0033	0.05	0.051
Endosulfan II	0.0052	0.05	0.051
Endosulfan sulfate	0.0061	0.05	0.05
Endrin	0.0084	0.06	0.06
Endrin aldehyde	0.0069	0.05	0.05
Gamma-BHC (Lindane)	0.0037	0.05	0.052
Gamma-chlordane	0.0022	0.03	0.03
Heptachlor	0.0030	0.03	0.03
Heptachlor epoxide	0.0023	0.01	0.01
Methoxychlor	0.0226	0.12*	0.05
Toxaphene	1.1	3.0*	2.4
Aroclor-1016	0.094	0.5	0.5
Aroclor-1221	0.084	0.5	0.5
Aroclor-1232	0.23	0.5	0.5
Aroclor-1242	0.37	0.5[4]	0.5
Aroclor-1248	0.11	0.5	0.5
Aroclor-1254	0.11	0.5	0.5
Aroclor-1260	0.095	0.5	0.5
APPENDIX IX HERBICIDES (SW-846 METHOD 8151A)			
2,4-D	0.021	0.2	70
2,4,5-T	0.011	0.2	370
2,4,5-TP (Silvex)	0.003	0.2	50
Dinoseb	0.035	0.2	0.39
Hexachlorophene	0.034	0.5	11
DIOXINS/FURANS (SW-846 METHOD 8290)			
2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)	6.1E-6	1E-5*	4.5E-6
1,2,3,7,8-Pentachlorodibenzo-p-dioxin (1,2,3,7,8-PeCDD)	2.24E-5	5E-5*	9E-6[7]
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,6,7,8-HxCDD)	9.8E-6	5E-5*	4.5E-5[7]
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (1,2,3,4,7,8-HxCDD)	6.1E-6	5E-5*	4.5E-5[7]
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (1,2,3,7,8,9-HxCDD)	1.76E-5	5E-5*	4.5E-5[7]
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (1,2,3,4,6,7,8-HpCDD)	1.78E-5	5E-5	4.5E-4[7]
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (1,2,3,4,6,7,8,9-OCDD	2.6E-5	1E-4	4.5E-3[7]
2,3,7,8-Tetrachlorodibenzofuran (2,3,7,8-TCDF)	6.6E-6	1E-5	4.5E-5[7]
1,2,3,7,8-Pentachlorodibenzofuran (1,2,3,7,8-PeCDF)	1.49E-5	5E-5	9E-5[7]
2,3,4,7,8-Pentachlorodibenzofuran (2,3,4,7,8-PeCDF)	1.62E-5	5E-5*	9E-6[7]
1,2,3,6,7,8-Hexachlorodibenzofuran (1,2,3,6,7,8-HxCDF)	1.62E-5	5E-5*	4.5E-5[7]
1,2,3,7,8,9-Hexachlorodibenzofuran (1,2,3,7,8,9-HxCDF)	1.42E-5	5E-5*	4.5E-5[7]
1,2,3,4,7,8-Hexachlorodibenzofuran (1,2,3,4,7,8-HxCDF)	1.93E-5	5E-5*	4.5E-5[7]
2,3,4,6,7,8-Hexachlorodibenzofuran (2,3,4,6,7,8-HxCDF)	2.4E-5	5E-5*	4.5E-5[7]
1,2,3,4,6,7,8-Heptachlorodibenzofuran (1,2,3,4,6,7,8-HpCDF)	1.88E-5	5E-5	4.5E-4[7]
1,2,3,4,7,8,9-Heptachlorodibenzofuran (1,2,3,4,7,8,9-HpCDF)	2.84E-5	5E-5	4.5E-4[7]
1,2,3,4,6,7,8,9-Octachlorodibenzofuran (1,2,3,4,6,7,8,9-OCDF)	3.03E-5	1E-4	4.5E-3[7]

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 7 OF 7

Chemical	Laboratory MDL/IDL[1] (ug/L)	Laboratory RL[1] (ug/L)	Risk-Based Target Level[2] (ug/L)
Total Tetrachlorodibenzo-p-dioxin (Total TCDD)	NA[8]	1E-5	NA
Total Pentachlorodibenzo-p-dioxin (Total PeCDD)	NA	5E-5	NA
Total Hexachlorodibenzo-p-dioxin (Total HxCDD)	NA	5E-5	NA
Total Heptachlorodibenzo-p-dioxin (Total HpCDD)	NA	5E-5	NA
Total Tetrachlorodibenzofuran (Total TCDF)	NA	1E-5	NA
Total Pentachlorodibenzofuran (Total PeCDF)	NA	5E-5	NA
Total Hexachlorodibenzofuran (Total HxCDF)	NA	5E-5	NA
Total Heptachlorodibenzofuran (Total HpCDF)	NA	5E-5	NA
MISCELLANEOUS PARAMETERS			
Ammonia (EPA Method 350.1)	6.4	10	--
Chloride (SW-846 Method 9056)	80	1000	--
Cyanide (SW-846 Method 9012A)	2.4	10	10
Dissolved Ethane (Microseeps, Inc., Method AM18)	0.0008	0.005	100[9]
Dissolved Ethene (Microseeps, Inc., Method AM18)	0.0013	0.005	10[9]
Dissolved Methane (Microseeps, Inc., Method AM18)	0.005	0.015	5[9]
Phosphorus (Total and Dissolved) (EPA Method 365.2)	31.2	100	--
Sulfate (SW-846 Method 9056)	74.2	1000	--
Sulfide (SW-846 Method 9034)	800	1000	--
Total Organic Carbon (TOC) (SW-846 Method 9060)	306	1000	--
Total Organic Halides (TOX) (SW-846 Method 9020B)	8.8	20	--

ug/L micrograms per liter

* Asterisks indicate those chemicals for which the laboratory RL exceeds the risk-based target level for the project.

1 Method detection limits (MDLs) (all parameters except metals), instrument detection limits (IDLs) (metals only), and reporting limits (RLs) as provided by Laucks Testing Laboratories, Inc., Triangle Laboratories, Inc. (dioxins/furans only), and Microseeps, Inc. (dissolved methane only). These values may change throughout the course of the ground water monitoring program as laboratory MDLs and IDLs are updated.

2 Developed using U.S. EPA Region 5 support. Value is based on human health or ecological risk-based criteria or practical quantitation limits (PQLs) for common laboratory analytical methods.

3 Risk-based target level is not provided, since human and ecological risk-based criteria are not available for this chemical.

4 Laucks Testing Laboratories is confident that it can reliably report to this PQL, even though this value is less than two times the MDL.

5 3-Methylphenol and 4-methylphenol coelute. Therefore, one analytical result for 3-, 4-methylphenol will be reported.

6 N-Nitrosodiphenylamine is more toxic than diphenylamine. However, n-nitrosodiphenylamine rapidly degrades to diphenylamine. Therefore, only diphenylamine will be reported, but results for diphenylamine will be treated as n-nitrosodiphenylanine during risk assessment.

7 The target level is calculated using the target level for 2,3,7,8-TCDD and the toxicity equivalent factor (TEF) presented in current U.S. EPA guidance (U.S. EPA, March 1989).

8 Not applicable.

9 The target levels for dissolved ethane, ethene, and methane are not risk-based values, but instead represent the target reporting levels for these dissolved gases based on their use in evaluating the natural attenuation of TCE.

to determine whether downgradient well concentrations are statistically greater than upgradient well concentrations. Background concentration levels will be established using the first four rounds of ground water data obtained as part of this ground water monitoring program.

1.4.2.1 Field Parameters

Measurements of dissolved oxygen, pH, specific conductivity, temperature, turbidity, oxidation-reduction potential (ORP), and water level will be performed during each sampling event at the ABG, ORR, DR, and OJT. Alkalinity (carbonate, bicarbonate, and hydroxide) measurements will be performed for all samples collected from the ABG. In addition, measurements of alkalinity (carbonate, bicarbonate, and hydroxide), carbon dioxide, ferrous iron, hydrogen sulfide, nitrate, and nitrite will be performed for samples collected to monitor natural attenuation. Flow rate and direction will be determined at each unit annually.

1.4.2.2 Laboratory Parameters

The list of laboratory parameters (and likely chemicals of concern) for each unit was developed based on RCRA ground water monitoring requirements in 40 CFR Subpart F and site-specific information (i.e., known waste composition and treatment residues, results of previous ground water monitoring, etc.) and general knowledge of open burning/open detonation at NSWC Crane. Additional guidance regarding the parameter list for the evaluation of natural attenuation of chlorinated solvents was obtained from the U.S. EPA document entitled "Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water" (U.S. EPA, September 1998). The general list of laboratory parameters to be analyzed is provided in Table 1-1 on a unit-specific basis. Further details regarding the specific sampling and analytical program for each unit are provided in Tables 4-1 through 4-9 of the approved FSP. During the first year of ground water monitoring, the analytical program will consist of a full suite of Appendix IX organic parameters (volatiles, semivolatiles, pesticides/PCBs, herbicides, and dioxins/furans). However, if these chemicals are not detected during the first annual sampling, a permit modification specifying a reduced list of Appendix IX parameters will be requested for approval by the U.S. EPA for future annual monitoring activities.

In general, the list of chosen analytical methods is composed of U.S. EPA SW-846 methods. Specific chemicals to be included in each analytical fraction, as well as identifications of the analytical methods to be used, are presented in Table 1-3. Further information, including references, regarding analytical methods is provided in Section 7.0.

It should be noted that the target analyte list for volatile organics contains all of the suspected chemicals of concern for the ABG, including trichloroethene and its associated degradation products (1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, and vinyl chloride). As shown in Table 1-1, the target analyte list for samples to be collected for the evaluation of natural attenuation includes several volatile aromatic and chlorinated hydrocarbons (trichloroethene and its previously noted degradation products, tetrachloroethene, 1,1,1-trichloroethane, 1,1-dichloroethane, 1,2-dichloroethane, carbon tetrachloride, chloroform, chloroethane, methylene chloride, benzene, toluene, ethylbenzene, and total xylenes).

It should also be noted that the full list of explosives constituents included in Table 1-3 will not be analyzed for each sample; the target analyte list of explosives will vary based upon the specific operating unit and/or sampling event. Appendix D of the approved FSP presents three subsets of the explosives constituents list, and Tables 4-2, 4-3, 4-4, 4-6, 4-7 and 4-9 of the approved FSP indicate, for each sample based on the unit and sampling event, which subset(s) of the explosives constituents list will be analyzed. Explosives constituents handled at NSWC Crane as well as explosives constituents typically found in military munitions are included in Subset A; analysis for this subset of the explosives list will be performed for all samples scheduled for analysis for explosives, regardless of the operating unit or sampling event. Picric acid and picramic acid (Subset C) have been added to the target analyte list for samples to be collected from the ORR because these analytes are degradation products of an explosive ("Yellow D" containing ammonium picrate) that has been frequently handled at the unit. The target analyte list for explosives for ground water samples to be collected from the ABG for the evaluation of natural attenuation will also include Subset B, which consists of several explosives degradation products (2,4-diamino-6-nitrotoluene, 2,6-diamino-4-nitrotoluene, 2,2',6,6'-tetranitro-4,4'-azoxytoluene (4,4'-TN-AZOXY), 3,5-dinitroaniline, 1,3,5-trinitroso-1,3,5-hexahydrotriazine (TNX), 1-nitroso-3,5-dinitro-1,3,5-hexahydrotriazine (MNX), and picric acid). If any of these parameters are found in the unit's plume, they will be added to the compliance list.

Also included in Table 1-3 are the project-specific risk-based target levels and laboratory-specific method detection limits (MDLs; all parameters except metals), instrument detection limits (IDLs; metals only), and reporting limits (RLs) for the target parameters and chosen analytical methods. The risk-based target levels presented in Table 1-3, which were developed specifically for this project using U.S. EPA Region 5 support, are based on 1998 human and ecological risk values. A tabular presentation of the human health and ecological risk-based criteria used as a basis for determining the target levels is provided in Appendix A, Table A-1. In some cases, the target level was established at the lowest limit of detection available using common laboratory analytical methods since the risk-based level could not be reached analytically.

TtNUS worked closely with the subcontracted analytical laboratories to select and optimize analytical methods in an effort to attain, to the greatest extent possible, laboratory RLs at concentrations less than or equal to the risk-based target levels. For example, as noted on Table 1-3, analysis for polynuclear aromatic hydrocarbons (PAHs) will be performed using SW-846 Method 8270C with selective ion monitoring (SIM) in order to achieve RLs at concentrations less than respective target levels for PAHs. Other examples of steps taken to achieve lower RLs include the use of SW-846 Method 6020 (Inductively Coupled Plasma/Mass Spectrometry [ICP/MS]) in place of SW-846 Method 6010B (Inductively Coupled Plasma/Atomic Emission Spectroscopy [ICP/AES]) for the Appendix IX metals and the use of a 25 mL sample volume for volatile analysis by SW-846 Method 8260B.

However, based on the limitations of best available technology, RLs for some analytes still do not meet the associated risk-based target levels; the laboratory RLs of these analytes are marked with asterisks (*) on Table 1-3. The RLs and risk-based target levels of these specific analytes were discussed on an analyte-by-analyte basis during the previously noted meeting which took place on December 30, 1997, at U.S. EPA Region 5 headquarters. It was determined during this meeting that the RLs for these analytes are sufficient to meet the objectives of the ground water monitoring program at NSWC Crane. The following paragraphs summarize the rationale for the conclusions that were reached during this meeting.

The RLs for five volatile organic compounds (VOCs) (acrolein; carbon tetrachloride; chloroform; cis-1,3-dichloropropane; and 1,4-dioxane), 12 semivolatile organic compounds (SVOCs) (1-naphthylamine; 2,3,4,6-tetrachlorophenol; 2,4,6-trichlorophenol; 2-chloronaphthalene; 2-chlorophenol; 3,3'-dimethylbenzidine; chlorobenzilate; disulfoton; hexachlorophene; kepone; methyl parathion; and phorate), and four pesticides (4,4'-DDE; 4,4'-DDT; methoxychlor; and toxaphene) exceed the associated risk-based target levels. None of these specific VOCs or SVOCs are associated with explosives (the primary contaminants at the site) nor are they expected to be present based on the historical use of the site. Pesticides in general (as a class of compounds) are not expected to be present based upon historical use of the site. In addition, although the RL for 1,4-dioxane (which is set at the concentration of the low calibration standard) and the RL for kepone exceed the associated target levels by 250 times and approximately 10 times, respectively, these analytes are very difficult to analyze, as confirmed by the Region 5 QA Coordinator during the meeting of December 30, 1997. The subcontracted laboratory also performed an MDL study for kepone using SW-846 Method 8081 in an attempt to obtain a lower RL, but the results for kepone using this method were very poor; in fact, SW-846 Method 8081 recommends the use of SW-846 Method 8270C for the analysis of kepone.

Three of the SVOCs noted in the previous paragraph (disulfoton, methyl parathion, and phorate) as well as two other SVOCs (ethyl parathion and famphur) are organophosphorus pesticides which could also be analyzed by SW-846 Method 8141. However, organophosphorus pesticides are not expected to be present based upon site history; therefore it was determined that the RLs for these analytes obtained through the use of SW-846 Method 8270C are sufficient to meet the objectives of the project.

The laboratory RLs for five dioxins (2,3,7,8-TCDD; 1,2,3,7,8-PeCDD; 1,2,3,6,7,8-HxCDD; 1,2,3,4,7,8-HxCDD; and 1,2,3,7,8,9-HxCDD) and five furans (2,3,4,7,8-PeCDF; 1,2,3,6,7,8-HxCDF; 1,2,3,4,7,8-HxCDF; 1,2,3,7,8,9-HxCDF and 2,3,4,6,7,8-HxCDF) exceed the associated risk-based target levels. Although dioxins/furans are not generally associated with explosives, they could be associated with past burning of explosive-contaminated solvents and plastics at the ABG. However, any releases of dioxins/furans would have been to the soil. Since dioxins/furans are relatively immobile in soil, they would not be expected to leach into the ground water (U.S. EPA, February 1984). Therefore, dioxins/furans are not expected to be present in site ground water.

The method to be used for the analysis of pesticides/PCBs was also discussed during the meeting of December 30, 1997. It was noted that the recent third update of SW-846 methods separates the analysis of pesticides and PCBs into two different methods (Methods 8081A and 8082, respectively). As previously noted, pesticides and PCBs are not expected to be present at the open burning/open detonation (OB/OD) units at NSWC Crane based on site history. Therefore, it was determined during the meeting that it is appropriate to use SW-846 Method 8081 (from the second update of the SW-846 methods) for the analysis of pesticides and PCBs since the RLs would not differ significantly using Method 8081 and since the sampling and analytical costs would be lower to analyze both pesticides and PCBs using a single method instead of two separate methods. As an extra QC measure, a PCB (Aroclor-1260) will be added to the spiking lists for matrix spike (MS) and laboratory control sample (LCS) analyses for pesticide/PCBs (see Tables 3-9 and 3-10 in Section 3 of this QAPP).

Based on the length of time of the ground water monitoring program (lifetime of the unit), some updates of analytical methods (based on U.S. EPA updates of SW-846 methods) and associated quality control (QC) limits may occur. This could involve updates of laboratory Standard Operating Procedures (SOPs) (as needed); updates of control limits on a regular basis (approximately annually); and/or updates of laboratory MDLs (annually), IDLs (quarterly), and RLs (as needed based on updated MDLs/IDLs). These potential changes are unavoidable because of changes in technology over time. However, these changes are not expected to have a significant impact on attainment of the project DQOs. Updated MDLs, IDLs, and/or RLs will be reported to U.S. EPA Region 5 only if the updates result in RLs which exceed the risk-based target levels. Updated QC limits will be reported to U.S. EPA Region 5 only if the

limits for key analytes (e.g., explosives, metals, or other analytes which are associated with the site based on site history) degrade significantly. Additional information regarding QA reports is provided in Section 14.

Revisions of laboratory SOPs could potentially be classified as Class 1 or Class 2 permit modifications. Non-substantive revisions (e.g., changes in elution order of analytes based upon installation of a new chromatographic column, revisions based upon purchase and use of equivalent or superior equipment, typographical corrections, editorial reformatting, etc.) or revisions based upon updates in U.S. EPA guidance or regulations (e.g., promulgation of updates to SW-846 methods) would constitute Class 1 permit modifications. All substantive SOP revisions not based upon U.S. EPA guidance or regulations that could potentially impact the DQOs of the project would constitute Class 2 permit modifications. The approved QAPP will be distributed as a controlled document. As such, updates to the QAPP, including updated laboratory SOPs, will be provided to persons included on the distribution list along with the effective date of the revision and instructions for inserting the updates. The subcontracted laboratories will provide updated copies of project-related SOPs to TtNUS whenever the SOPs are revised. Notification of Class 1 modifications based upon SOP revisions will be made to U.S. EPA Region 5 as specified in 40 CFR Part 270.42(a). Approval for Class 2 permit modifications will be obtained through the procedures described in 40 CFR Part 270.42(b).

1.4.3 Data Quality Objectives

Ground water (ABG, ORR, DR, and OJT) and surface water (ABG) is being monitored for the following purposes:

- Compliance with permitting requirements, as described in 40 CFR 264 Subpart F, for ground water monitoring (ABG, ORR, and DR).
- Compliance with the Corrective Action requirements [RCRA Section 3004(u) and (v)] (ABG, ORR, and OJT).
- Compliance with closure requirements (waste pile and surface impoundments at the ABG).
- Determination of whether existing explosives, TCE, and metals contamination in the ground water at the ABG is being naturally attenuated.
- Monitoring of karst conditions at the ABG.

U.S. EPA Region 5 has established project-specific risk-based target levels or concentration limits for hazardous constituents in order to meet the requirements of the purposes for which ground water and surface water monitoring is to be conducted. These risk-based target levels are protective of human health and the environment. The overall objective of ground water and surface water monitoring at the ABG, ORR, DR, and the OJT is to meet requirements of the above listed purposes including the risk-based target levels for hazardous constituents established by U.S. EPA Region 5 or background. This objective is attained by the following activities:

- Reviewing past explosives-handling practices and historical Appendix IX monitoring results and integrating the information to develop data needs for the project.

- Developing a sampling and analysis plan that provides data with a high degree of representativeness of actual ground water conditions at the unit(s), including background.

- Selecting methods of analysis that are sensitive enough to meet the project-specific risk-based target levels.

- Obtaining and handling representative ground water samples through standardized and documented sampling procedures.

- Comparing the resulting analytical data to the project-specific risk-based target levels and background.

The specific DQOs for the project are, as follows:

- The objective of field sampling and laboratory analysis is to obtain 95 percent of the planned field measurements and obtain 95 percent of the planned laboratory analyses. However, it should be noted that the loss of critical data points, such as data for upgradient wells, may require resampling.

- The accuracy and precision of the resulting data will meet or exceed the QC limits established for this project.

- The laboratory-derived MDLs, IDLs, and RLs for the chosen analytical methods will meet or be less than the project-specific risk-based target levels used to assess potential adverse impacts, wherever practical.

- Comparability of analytical sample results will be obtained through the use of consistent units of concentration.

Detailed information on the specific objectives for the measurement of data, such as precision, accuracy, completeness, representativeness, and comparability, is provided in Section 3.0 of this QAPP.

1.5 SAMPLE NETWORK DESIGN AND RATIONALE

The ground water monitoring well network and rationale for the location of the monitoring well network is fully described in Sections 7, 8, and 9 of the approved Ground Water Monitoring Plan for the ABG, ORR, and DR, respectively. Rationale for the selection of the type of RCRA monitoring program (detection or compliance monitoring) is described in the approved Ground Water Monitoring Plan.

1.5.1 Sample Network by Task and Matrix

The frequency of ground water sample collection and the associated analytical parameters are summarized in Table 1-1. Further detail regarding the analytical program for each operating unit is provided in Tables 4-1 through 4-9 of the approved FSP.

1.5.2 Site Maps of Sampling Locations

Figures 7-1, 8-1, and 9-1 of the approved Ground Water Monitoring Plan show the locations of the ground water monitoring wells to be sampled at the ABG, ORR, and DR, respectively. Figure 7-1 of the approved Ground Water Monitoring Plan also includes spring and surface water sampling locations.

1.5.3 Rationale of Selected Sampling Locations

The rationale for choosing the selected ground water monitoring well locations and depths for each operating unit (ABG, ORR, and DR) is described in the approved Ground Water Monitoring Plan. Any requests for changes in location of monitoring wells would be made in writing to the implementing agency.

1.5.4 Sample Network Summary Table

The sample network for this project is presented in summary format in Table 1-1. Detailed information on the sampling network is presented in Section 4 of the approved FSP for the ABG, ORR, and DR.

1.6 PROJECT SCHEDULE

This section refers to the schedule, included in the approved FSP, for ground water monitoring activities at NSWC Crane.

1.6.1 Anticipated Date of Project Mobilization

The earliest date on which samples are planned to be collected is November 1998 (Ammunition Burning Ground only). Figure 5-1 of the approved FSP presents the overall project schedule.

1.6.2 Task Bar Chart and Associated Timeframes

The dates of projected milestones are shown in Figure 5-1 of the approved FSP.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The project organization for the NSWC Crane ground water monitoring program is provided in Section 1-1 of the approved FSP. A project organization chart is provided, and management, quality assurance, laboratory, and field responsibilities are discussed.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this project is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide results which are legally defensible in a court of law. Intended data uses are described in Section 1.4.2 of this QAPP. Specific procedures for sampling, chain-of-custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventive maintenance of field and laboratory equipment, and corrective action are described in other sections of this QAPP.

The PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are qualitative and/or quantitative statements regarding the quality characteristics of the data used to support project objectives and ultimately, environmental decisions. These parameters are discussed in the remainder of this section. Specific routine procedures used to assess the quantitative parameters (precision, accuracy, and completeness) are provided in Section 12.0.

3.1 PRECISION

3.1.1 Definition

Precision is a measure of the amount of variability and bias inherent in a data set. Precision describes the reproducibility of measurements of the same parameter for samples under similar conditions. The equation for determining precision for this project is provided in Section 12.2.

3.1.2 Field Precision Objectives

Field duplicate precision monitors the consistency with which environmental samples were obtained and analyzed. Field duplicate results for aqueous matrix samples are considered to be precise if the relative percent difference (RPD) is less than or equal to 30 percent. Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 10 analytical samples.

3.1.3 Laboratory Precision Objectives

Laboratory precision QC samples will be analyzed with a minimum frequency of 5 percent (i.e., 1 QC sample per 20 environmental samples). Laboratory precision is measured via comparison of RPD values and precision control limits specified in the analytical method or by the laboratory's QA/QC program. With

the exceptions of dissolved methane, ethane, and ethene analyses, precision for organic analyses will be measured via the RPDs for matrix spike/matrix spike duplicate (MS/MSD) samples. Precision for dissolved methane, ethane and ethene analyses will be measured via field duplicate samples only since laboratory duplicates are not applicable for these parameters. In addition, precision for dioxin/furan analysis will be measured via the RPDs for laboratory control sample/laboratory control sample duplicates (LCS/LCSDs). Precision for inorganic analyses will be measured via RPDs for laboratory duplicates. Tables 3-1, 3-3, 3-5, 3-7, 3-9, 3-11, 3-13, 3-14, and 3-15 present precision control limits for MS/MSD, LCS/LCSD, and laboratory duplicate RPDs, as applicable, for each analytical fraction. (Tables 3-2, 3-4, 3-6, 3-8, 3-10, 3-12, and 3-16 present accuracy control limits, which are discussed in Section 3.2.).

3.2 ACCURACY

3.2.1 Definition

Accuracy is the degree of agreement between an observed value and an accepted reference value. The equation for determining accuracy for this project is provided in Section 12.1.

3.2.2 Field Accuracy Objectives

Accuracy in the field is assessed through the use of rinsate and trip blanks and is ensured through adherence to all sample handling, preservation, and holding time requirements. Accuracy and precision requirements for field measurements (e.g., pH) are ensured through routine instrument calibration, as discussed in Section 4.5 of the approved FSP.

3.2.3 Laboratory Accuracy Objectives

Accuracy in the laboratory is measured through the comparison of a spiked sample result to a known or calculated value and is expressed as a percent recovery (%R). Percent recoveries are derived from the analysis of known amounts of compounds spiked into deionized water (i.e., LCS analysis), or into actual samples (i.e., surrogate or MS analysis). LCS analysis, which may also be referred to as blank spike analysis, measures the accuracy of laboratory operations. Surrogate and MS analyses measure the accuracy of laboratory operations as affected by sample matrix. LCS and MS analyses are performed at a frequency of 1 per 20 associated samples of like matrix. Surrogate spike analysis is performed for all organic chromatographic analyses with the exceptions of dissolved methane and dioxin/furan analyses.

TABLE 3-1

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
EXPLOSIVES ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 2

Chemical	Accuracy (%R)	Precision (RPD)
EXPLOSIVES BY SW-846 METHOD 8330		
1,3,5-Trinitrobenzene	44-142	30
1,3-Dinitrobenzene	32-122	30
2,4,6-Trinitrotoluene	59-114	30
2,4-Dinitrotoluene	42-110	30
2,6-Dinitrotoluene	38-106	30
HMX	10-96	30
2-Nitrotoluene	30-99	30
3-Nitrotoluene	28-105	30
4-Nitrotoluene	31-100	30
4-Amino-2,6-dinitrotoluene	58-117	30
2-Amino-4,6-dinitrotoluene	58-117	30
Tetryl	27-109	30
Nitrobenzene	31-99	30
RDX	47-125	30
Nitroglycerin	30-150[2]	50[2]
PETN	30-150[2]	50[2]
2,4-Diamino-6-nitrotoluene[3]	30-150[4]	50[4]
2,6-Diamino-4-nitrotoluene[3]	30-150[4]	50[4]
4,4'-TN-AZOXY[3]	30-150[4]	50[4]
3,5-Dinitroaniline[3]	30-150[4]	50[4]
TNX[3]	30-150[4]	50[4]
MNX[3]	30-150[4]	50[4]
1,2-Dinitrobenzene (surrogate)	60-140	NA[5]
EXPLOSIVES BY LAUCKS HPLC METHOD		
Picric acid	48-152[6]	50
Picramic acid	60-128[6]	26
4,6-dinitro-o-cresol (surrogate)	50-150[4]	NA
EXPLOSIVES BY MODIFIED ARMY CORPS METHOD		
Nitrocellulose	30-150[4]	50[4]

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
2 Laucks will perform the preparative extraction for these analytes in the same manner as the remaining analytes but will analyze for them using a 210 wavelength (similar to SW-846 Method 8332) rather than a wavelength of 254. Statistical QC limits will be developed once 20 data points are obtained. The default limits presented will be used until that time.

TABLE 3-1

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
EXPLOSIVES ANALYSES
NSWC CRANE, CRANE, INDIANA
PAGE 2 OF 2

3 These compounds will only be included in matrix spike analyses associated with samples from the ABG collected to evaluate natural attenuation.
4 Statistical QC limits will be developed once 20 data points are obtained. The default limits presented will be used until that time.
5 Not applicable
6 These QC limits were developed prior to 1995. New limits will be developed once 20 data points are obtained. The limits presented will be used until that time.

TABLE 3-2

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
EXPLOSIVES ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 2

Chemical	Accuracy (%R)
EXPLOSIVES BY SW-846 METHOD 8330	
1,3,5-Trinitrobenzene	52-125
1,3-Dinitrobenzene	53-122
2,4,6-Trinitrotoluene	51-134
2,4-Dinitrotoluene	55-129
2,6-Dinitrotoluene	49-132
HMX	29-135
2-Nitrotoluene	41-140
3-Nitrotoluene	40-145
4-Nitrotoluene	39-142
4-Amino-2,6-dinitrotoluene	60-125
2-Amino-4,6-dinitrotoluene	61-125
Methyl-2,4,6-Trinitrophenylnitramine	33-138
Nitrobenzene	40-134
RDX	44-125
Nitroglycerin	30-150[2]
PETN	30-150[2]
2,4-Diamino-6-nitrotoluene[3]	30-150[4]
2,6-Diamino-4-nitrotoluene[3]	30-150[4]
4,4'-TN-AZOXY[3]	30-150[4]
3,5-Dinitroaniline[3]	30-150[4]
TNX[3]	30-150[4]
MNX[3]	30-150[4]
EXPLOSIVES BY LAUCKS HPLC METHOD	
Picric acid	40-160[5]
Picramic acid	40-160[5]
EXPLOSIVES BY MODIFIED ARMY CORPS METHOD	
Nitrocellulose	30-150[4]

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.

2 Laucks will perform the preparative extraction for these analytes in the same manner as the remaining analytes but will analyze for them using a 210 wavelength (similar to SW-846 Method 8332) rather than a wavelength of 254. Statistical QC limits will be developed once 20 data points are obtained. The default limits presented will be used until that time.

TABLE 3-2

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
EXPLOSIVES ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 2

3 These compounds will only be included in matrix spike analyses associated with samples from the ABG collected to evaluate natural attenuation.
4 Statistical QC limits will be developed once 20 data points are obtained. The default limits presented will be used until that time.
5 These QC limits were developed prior to 1995. New limits will be developed once 20 data points are obtained. The limits presented will be used until that time.

TABLE 3-3

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE AND LABORATORY DUPLICATE SAMPLES
METALS ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)	Precision (RPD)
APPENDIX IX METALS BY SW-846 METHOD 6020 (UNLESS OTHERWISE NOTED)		
Antimony	75-125	20
Arsenic	75-125	20
Barium	75-125	20
Beryllium	75-125	20
Cadmium	75-125	20
Chromium (total)	75-125	20
Cobalt	75-125	20
Copper	75-125	20
Lead	75-125	20
Mercury (SW-846 Method 7070A)	75-125	20
Nickel	75-125	20
Selenium	75-125	20
Silver	75-125	20
Thallium	75-125	20
Tin	75-125	20
Vanadium	75-125	20
Zinc	75-125	20
ADDITIONAL METALS BY SW-846 METHOD 6010B		
Calcium	75-125	20
Iron	75-125	20
Magnesium	75-125	20
Manganese	75-125	20
Potassium	75-125	20
Sodium	75-125	20

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.

TABLE 3-4

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
METALS ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)
APPENDIX IX METALS BY SW-846 METHOD 6020 (UNLESS OTHERWISE NOTED)	
Antimony	75-125
Arsenic	80-120
Barium	80-120
Beryllium	80-120
Cadmium	80-120
Chromium (total)	80-120
Cobalt	80-120
Copper	80-120
Lead	80-120
Mercury (SW-846 Method 7470A)	80-120
Nickel	80-120
Selenium	80-120
Silver	75-125
Thallium	80-120
Tin	80-120
Vanadium	80-120
Zinc	80-120
ADDITIONAL METALS BY SW-846 METHOD 6010B	
Calcium	80-120
Iron	80-120
Magnesium	80-120
Manganese	80-120
Potassium	80-120
Sodium	80-120

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.

TABLE 3-5

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
VOLATILE ORGANIC COMPOUND ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 2

Chemical	Accuracy (%R)	Precision (RPD)
VOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8260B[2]		
1,1,1-Trichloroethane	75-125	20
1,1,2,2-Tetrachloroethane	74-125	20
1,1,2-Trichloroethane	75-127	20
1,1-Dichloroethane	72-125	20
1,1-Dichloroethene	59-145	20
1,2-Dichloroethane	68-127	20
1,2-Dichloropropane	70-125	20
2-Butanone	70-125	20
2-Hexanone	70-125	20
4-Methyl-2-pentanone	70-125	20
Acetone	70-125	20
Benzene	62-142	20
Bromodichloromethane	75-125	20
Bromoform	75-125	20
Bromomethane	72-175	20
Carbon disulfide	70-125	20
Carbon tetrachloride	62-125	20
Chlorobenzene	62-135	20
Chloroethane	65-125	20
Chloroform	74-125	20
Chloromethane	75-125	20
cis-1,2-Dichloroethene	75-125	20
trans-1,2-Dichloroethene	75-125	20
cis-1,3-Dichloropropene	74-125	20
trans-1,3-Dichloropropene	66-125	20
Dibromochloromethane	75-125	20
Ethylbenzene	75-125	20
Methylene chloride	75-125	20
Styrene	75-125	20
Tetrachloroethene	71-125	20
Toluene	59-139	20
Trichloroethene	54-141	20
Vinyl chloride	46-134	20
Xylenes (Total)	75-125	20

TABLE 3-5

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
VOLATILE ORGANIC COMPOUND ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 2

Chemical	Accuracy (%R)	Precision (RPD)
VOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8260B[2] (CONTINUED)		
Toluene-D8 (surrogate)	75-125	NA[3]
1,2-Dichloroethane-D4 (surrogate)	62-139	NA
4-Bromofluorobenzene (surrogate)	75-125	NA
ADDITIONAL VOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8015B		
1,4-Dioxane	30-140[4]	50
Acetonitrile	59-139	20
Isobutyl alcohol	67-128	18
Propionitrile	76-125	15
4-Bromofluorobenzene (surrogate)	70-130	NA

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
2 When analyzing samples for a shortened list of volatile organic compounds (e.g., for natural attenuation monitoring), only those compounds included in the analytical target list will be evaluated for matrix spike accuracy and precision.
3 Not applicable.
4 Statistical QC limits will be developed once 20 data points are obtained. The default limits presented will be used until that time.

TABLE 3-6

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
VOLATILE ORGANIC COMPOUND ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)
VOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8260B	
1,1-Dichloroethene	71-130
Benzene	85-122
Chlorobenzene	84-114
Trichloroethene	86-117
Toluene	80-120
ADDITIONAL VOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8015B	
Acetonitrile	69-136
Isobutyl alcohol	72-130
Propionitrile	83-123

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.

TABLE 3-7

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
SEMIVOLATILE ORGANIC COMPOUND ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 3

Chemical	Accuracy (%R)	Precision (RPD)
SEMIVOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8270C		
1,2,4-Trichlorobenzene	43-103	20
1,2-Dichlorobenzene	42-155	20
1,3-Dichlorobenzene	36-125	20
1,4-Dichlorobenzene	33-96	20
2-Chloronaphthalene	60-125	20
2-Chlorophenol	41-115	20
2-Methylphenol	25-125	20
2-Nitroaniline	50-125	20
2-Nitrophenol	44-125	20
2,4-Dichlorophenol	46-125	20
2,4-Dimethylphenol	45-139	20
2,4-Dinitrophenol	30-151	20
2,4,5-Trichlorophenol	25-175	20
2,4,6-Trichlorophenol	39-128	20
3-Nitroaniline	51-125	20
3,3'-Dichlorobenzidine	29-175	20
4-Bromophenyl phenyl ether	53-127	20
4-Chloroaniline	45-136	20
4-Chloro-3-methylphenol	49-121	20
4-Chlorophenyl phenyl ether	51-132	20
4-Methylphenol	33-125	20
4-Nitroaniline	40-143	20
4-Nitrophenol	38-134	20
4,6-Dinitro-2-methylphenol	26-134	20
Bis(2-chloroethoxy)methane	49-125	20
Bis(2-chloroethyl)ether	44-125	20
Bis(2-chloroisopropyl)ether	36-166	20
Bis(2-ethylhexyl)phthalate	33-129	20
Butyl benzyl phthalate	26-125	20
Di-n-butyl phthalate	34-126	20
Di-n-octyl phthalate	38-127	20
Dibenzofuran	52-125	20
Diethyl phthalate	37-125	20
Dimethyl phthalate	25-175	20
Hexachlorobenzene	46-133	20
Hexachlorobutadiene	25-125	20

TABLE 3-7

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
SEMIVOLATILE ORGANIC COMPOUND ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 3

Chemical	Accuracy (%R)	Precision (RPD)
SEMIVOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8270C (CONTINUED)		
Hexachlorocyclopentadiene	41-125	20
Hexachloroethane	25-153	20
Isophorone	26-175	20
n-Nitrosodi-n-propylamine	53-128	20
n-Nitrosodiphenylamine	27-125	20
Pentachlorophenol	60-131	20
Phenol	33-112	20
2,4,6-Tribromophenol (surrogate)	30-136	NA
2-Fluorobiphenyl (surrogate)	47-124	NA
2-Fluorophenol (surrogate)	33-115	NA
Nitrobenzene-D5 (surrogate)	33-117	NA
Phenol-D5 (surrogate)	45-112	NA
Terphenyl-D14 (surrogate)	51-135	NA
POLYNUCLEAR AROMATIC HYDROCARBONS BY SW-846 METHOD 8270C WITH SIM		
2-Methylnaphthalene	20-160[3]	30
Acenaphthylene	20-160[3]	30
Acenaphthene	20-160[3]	30
Anthracene	20-160[3]	30
Benzo(a)anthracene	20-160[3]	30
Benzo(a)pyrene	20-160[3]	30
Benzo(b)fluoranthene	20-160[3]	30
Benzo(k)fluoranthene	20-160[3]	30
Benzo(g,h,i)perylene	20-160[3]	30
Chrysene	20-160[3]	30
Dibenzo(a,h)anthracene	20-160[3]	30
Fluoranthene	20-160[3]	30
Fluorene	20-160[3]	30
Indeno(1,2,3-c,d)pyrene	20-160[3]	30
Naphthalene	20-160[3]	30
Phenanthrene	20-160[3]	30
Pyrene	20-160[3]	30
1-Fluoronaphthalene (surrogate)	20-160[3]	NA
Fluorene-D10 (surrogate)	20-160[3]	NA
Pyrene-D10 (surrogate)	20-160[3]	NA

TABLE 3-7

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
SEMIVOLATILE ORGANIC COMPOUND ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 3 OF 3

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
2 Not applicable.
3 Statistical QC limits will be developed once 20 data points are obtained. The default limits presented will be used until that time.

TABLE 3-8

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
SEMIVOLATILE ORGANIC COMPOUND ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)
SEMIVOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8270C	
1,2,4-Trichlorobenzene	56-95
1,4-Dichlorobenzene	39-91
2-Chlorophenol	46-106
4-Chloro-3-methylphenol	52-109
4-Nitrophenol	30-124
n-Nitrosodi-n-propylamine	59-121
Pentachlorophenol	56-119
Phenol	30-105
POLYNUCLEAR AROMATIC HYDROCARBONS BY SW-846 METHOD 8270C WITH SIM	
2-Methylnaphthalene	20-160[2]
Acenaphthylene	20-160[2]
Acenaphthene	20-160[2]
Anthracene	20-160[2]
Benzo(a)anthracene	20-160[2]
Benzo(a)pyrene	20-160[2]
Benzo(b)fluoranthene	20-160[2]
Benzo(k)fluoranthene	20-160[2]
Benzo(g,h,i)perylene	20-160[2]
Chrysene	20-160[2]
Dibenzo(a,h)anthracene	20-160[2]
Fluoranthene	20-160[2]
Fluorene	20-160[2]
Indeno(1,2,3-c,d)pyrene	20-160[2]
Naphthalene	20-160[2]
Phenanthrene	20-160[2]
Pyrene	20-160[2]

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
2 Statistical QC limits will be developed once 20 data points are obtained. The default limits presented will be used until that time.

TABLE 3-9

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
ORGANOCHLORINE PESTICIDE AND PCB ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)	Precision (RPD)
ORGANOCHLORINE PESTICIDES AND PCBS BY SW-846 METHOD 8081		
α-BHC	75-125	30
β-BHC	51-125	30
δ-BHC	75-126	30
γ-BHC (Lindane)	33-141	36
α-Chlordane	41-125	30
γ-Chlordane	41-125	30
4,4'-DDD	48-136	30
4,4'-DDE	45-139	30
4,4'-DDT	35-143	28
Aldrin	24-128	27
Dieldrin	40-135	23
Endosulfan I	49-143	30
Endosulfan II	75-159	30
Endosulfan sulfate	46-141	30
Endrin	44-140	34
Endrin aldehyde	75-150	30
Heptachlor	30-123	29
Heptachlor epoxide	53-134	30
Methoxychlor	73-142	30
Aroclor-1260	40-126	30
Decachlorobiphenyl (surrogate)	30-160	NA[2]
Tetrachloro-m-xylene (surrogate)	25-139	NA

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.

2 Not applicable.

TABLE 3-10

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
ORGANOCHLORINE PESTICIDE AND PCB ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)
ORGANOCHLORINE PESTICIDES AND PCBS BY SW-846 METHOD 8081	
γ-BHC (Lindane)	55-143
Aldrin	38-122
Heptachlor	45-109
Aroclor-1260	47-133

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.

TABLE 3-11

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES
HERBICIDE ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)	Precision (RPD)
HERBICIDES BY SW-846 METHOD 8151A		
2,4-D	42-160	30
2,4,5-T	45-150	30
2,4,5-TP (Silvex)	30-160	30
Dinoseb	50-125	30
Hexachlorophene	20-160	50
2,6-Dichlorobenzoic acid (surrogate)	45-93	NA[2]
2,4-Dichlorophenylacetic acid (surrogate)	50-101	NA

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.

2 Not applicable.

TABLE 3-12

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
HERBICIDE ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)
HERBICIDES BY SW-846 METHOD 8151A	
2,4-D	42-140
2,4,5-TP (Silvex)	40-150

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.

TABLE 3-13

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES
DIOXIN/FURAN ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)[2]	Precision (RPD)[3]
DIOXINS/FURANS BY SW-846 METHOD 8290		
2,3,7,8-TCDD	70-130	20
1,2,3,7,8-PeCDD	70-130	20
1,2,3,6,7,8-HxCDD	70-130	20
1,2,3,4,7,8-HxCDD	70-130	20
1,2,3,7,8,9-HxCDD	70-130	20
1,2,3,4,6,7,8-HpCDD	70-130	20
1,2,3,4,6,7,8,9-OCDD	70-130	20
2,3,7,8-TCDF	70-130	20
1,2,3,7,8-PeCDF	70-130	20
2,3,4,7,8-PeCDF	70-130	20
1,2,3,6,7,8-HxCDF	70-130	20
1,2,3,7,8,9-HxCDF	70-130	20
1,2,3,4,7,8-HxCDF	70-130	20
2,3,4,6,7,8-HxCDF	70-130	20
1,2,3,4,6,7,8-HpCDF	70-130	20
1,2,3,4,7,8,9-HpCDF	70-130	20
1,2,3,4,6,7,8,9-OCDF	70-130	20

1 In-house QC limits provided by Triangle Laboratories, Inc.
2 As specified in Section VIII.E.2 of SOP DHR182 (in Appendix B of QAPP), recoveries for up to two anlaytes may be as high as 145% or as low as 60% as long as the associated RPDs meet criteria.
3 As specified in Section VIII.E.3 of SOP DHR182 (in Appendix B of QAPP), RPDs for up to two analytes may be up to 35% as long as the associated percent recoveries meet criteria.

TABLE 3-14

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLE/LABORATORY CONTROL SAMPLE DUPLICATES
DIOXIN/FURAN ANALYSES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R) [2]	Precision (RPD) [3]
DIOXINS/FURANS BY SW-846 METHOD 8290		
2,3,7,8-TCDD	70-130	20
1,2,3,7,8-PeCDD	70-130	20
1,2,3,6,7,8-HxCDD	70-130	20
1,2,3,4,7,8-HxCDD	70-130	20
1,2,3,7,8,9-HxCDD	70-130	20
1,2,3,4,6,7,8-HpCDD	70-130	20
1,2,3,4,6,7,8,9-OCDD	70-130	20
2,3,7,8-TCDF	70-130	20
1,2,3,7,8-PeCDF	70-130	20
2,3,4,7,8-PeCDF	70-130	20
1,2,3,6,7,8-HxCDF	70-130	20
1,2,3,7,8,9-HxCDF	70-130	20
1,2,3,4,7,8-HxCDF	70-130	20
2,3,4,6,7,8-HxCDF	70-130	20
1,2,3,4,6,7,8-HpCDF	70-130	20
1,2,3,4,7,8,9-HpCDF	70-130	20
1,2,3,4,6,7,8,9-OCDF	70-130	20

1 In-house QC limits provided by Triangle Laboratories, Inc.
2 As specified in Section VIII.E.2 of SOP DHR182 (in Appendix B of QAPP), recoveries for up to two anlaytes may be as high as 145% or as low as 60% as long as the associated RPDs meet criteria.
3 As specified in Section VIII.E.3 of SOP DHR182 (in Appendix B of QAPP), RPDs for up to two analytes may be up to 35% as long as the associated percent recoveries meet criteria.

TABLE 3-15

QUALITY CONTROL LIMITS[1]
MATRIX SPIKE AND LABORATORY DUPLICATE SAMPLES
MISCELLANEOUS PARAMETERS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)	Precision (RPD)
MISCELLANEOUS PARAMETERS		
Ammonia (EPA Method 350.1)	53-120	10
Chloride (SW-846 Method 9056)	73-121	11
Cyanide (SW-846 Method 9012A)	64-135	11
Dissolved Ethane (Microseeps, Inc., GC Method)	NA[2]	NA
Dissolved Ethene (Microseeps, Inc., GC Method)	NA	NA
Dissolved Methane (Microseeps, Inc., GC Method)	NA	NA
Phosphorus (EPA Method 365.2)	54-129	27
Sulfate (SW-846 Method 9056)	88-115	20
Sulfide (SW-846 Method 9034)	30-150[3]	50[3]
Total Organic Carbon (SW-846 Method 9060)	70-119	11
Total Organic Halides (SW-846 Method 9020B)	60-134	24

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
2 Not applicable. Matrix spike and laboratory duplicate analysis are not applicable for this parameter.
3 Statistical QC limits will be developed once 20 data points are obtained. The default limits presented will be used until that time.

TABLE 3-16

QUALITY CONTROL LIMITS[1]
LABORATORY CONTROL SAMPLES
MISCELLANEOUS PARAMETERS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA

Chemical	Accuracy (%R)
MISCELLANEOUS PARAMETERS	
Ammonia (EPA Method 350.1)	75-125
Chloride (SW-846 Method 9056)	90-110
Cyanide (SW-846 Method 9012A)	75-125
Dissolved Ethane (Microseeps, Inc., GC Method)	NA[2]
Dissolved Ethene (Microseeps, Inc., GC Method)	NA
Dissolved Methane (Microseeps, Inc., GC Method)	NA
Phosphorus (EPA Method 365.2)	75-125
Sulfate (SW-846 Method 9056)	80-120
Sulfide (SW-846 Method 9034)	30-150[3]
Total Organic Carbon (SW-846 Method 9060)	80-120
Total Organic Halides (SW-846 Method 9020B)	75-125

1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
2 Not applicable. Laboratory control samples are not applicable for this parameter.
3 Statistical QC limits will be developed once 20 data points are obtained. The default limits presented will be used until that time.

Laboratory accuracy is assessed via comparison of calculated %R values to accuracy control limits specified in the analytical method or by the laboratory's QA/QC program.

Accuracy for organic analyses will be measured via the percent recoveries for surrogate spikes, MS/MSDs, and LCSs. Surrogate spike, MS/MSD, and LCS analyses are not applicable for dissolved methane, ethane, and ethene analyses; however, as discussed in the Addendum to Microseeps Method AM18.01 (in Appendix B of this QAPP), a QC check standard from a source independent of the calibration standards will be analyzed for dissolved methane. Accuracy for inorganic analyses will be measured via percent recoveries for MSs and LCSs. Tables 3-1 through 3-16 present accuracy control limits for MS, surrogate spike, and LCS recoveries, as applicable, for each analytical fraction.

3.3 COMPLETENESS

3.3.1 Definition

Completeness is a measure of the amount of usable, valid, analytical data obtained, compared to the amount expected to be obtained. Completeness is typically expressed as a percentage. The equation for completeness is presented in Section 12.3.

The ideal objective for completeness is 100 percent (i.e., every sample planned to be collected is collected; every sample submitted for analysis yields valid data). However, samples can be rendered unusable during shipping or preparation (e.g., bottles broken or extracts accidentally destroyed); errors can be introduced during analysis (e.g., loss of instrument sensitivity, introduction of ambient laboratory contamination), or strong matrix effects can become apparent (e.g., extremely low MS recovery). These instances result in data that do not meet QC criteria. Based on these considerations, 95 percent is considered an acceptable target for the data completeness objective. Completeness will be calculated for each quarterly, semi-annual, and annual sampling event of the ground water monitoring program. If critical data points are lost, resampling and/or reanalysis may be required.

Validation will be performed for 100 percent of the laboratory data for the ground water monitoring program based on the requirements of the analytical methods and this QAPP. To the extent practicable for SW-846 analyses, validation will also be performed in accordance with the Region 5 SOPs for Validation of CLP (Contract Laboratory Program) Organic and Inorganic Data (U.S. EPA Region 5, 1993a, 1993b) and the U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic and

Inorganic Data Review (U.S. EPA, 1994a, 1994b). Data rejected as a result of the validation process will be treated as unreliable, unusable data.

3.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid field measurements obtained from all the field measurements taken in the project. Field completeness for this project is expected to be greater than 95 percent.

3.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid laboratory measurements obtained from all the laboratory measurements taken in the project. Laboratory completeness for this project is expected to be greater than 95 percent.

3.4 REPRESENTATIVENESS

3.4.1 Definition

Representativeness is an expression of the degree to which the data accurately and precisely depict the actual characteristics of a population or environmental condition existing at an individual sampling point. Use of standardized sampling, handling, analytical, and reporting procedures ensures that the final data accurately represent actual site conditions.

3.4.2 Measures to Ensure Representativeness of Field Data

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the FSP is followed and that proper sampling techniques are used.

3.4.3 Measures to Ensure Representativeness of Lab Data

Representativeness in the laboratory is ensured by using the proper analytical procedures, meeting sample holding times, and analyzing and assessing field duplicate samples. The sampling network for the ground water monitoring program was designed to provide data representative of facility conditions. During development of this network, consideration was given to past waste disposal practices, existing analytical data, physical setting and processes, and constraints inherent to the RCRA program. The

rationale of the sampling network for the ABG, ORR, and DR is discussed in detail in Sections 7, 8, and 9, respectively, of the approved Ground Water Monitoring Plan.

3.5 COMPARABILITY

3.5.1 Definition

Comparability is defined as the confidence with which one data set can be compared to another (e.g., between sampling points; between sampling events). Comparability is achieved by using standardized sampling and analysis methods and data reporting formats (including use of consistent units of measure). Additionally, consideration is given to seasonal conditions and other environmental variations that could exist to influence analytical results.

3.5.2 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the FSP is followed and that proper sampling techniques are used. It is also dependent on recording field measurements using consistent units. Units to be used for field measurements are further discussed in Section 9.1.1.

3.5.3 Measures to Ensure Comparability of Lab Data

Planned analytical data will be comparable when similar sampling and analytical methods are used and documented. Results will be reported in units that ensure comparability with previous data. The units used for the laboratory measurements are further discussed in Section 9.1.2 of this QAPP.

3.6 LEVEL OF QC EFFORT

Trip blank, ambient blank, field duplicate, method blank, laboratory duplicate, laboratory control, and MS samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. Rinsate and source water blanks will also be collected if new monitoring wells are installed or if non-dedicated bailers/bladder pumps are used. Internal QC samples (i.e., laboratory QC samples) are discussed in Section 8.0 of this QAPP. External QC measures (i.e., field QC samples) consist of field duplicates, ambient blanks, trip blanks, source water blanks, and equipment rinsate blanks. Information gained from these analyses further characterizes the level of data quality obtained to support project

goals. Each of these types of field QC samples undergo the same preservation, analysis, and reporting procedures as the related environmental samples. Each type of field QC sample is discussed below.

In terms of ground water sampling, field duplicates are two samples collected independently at the same sampling location and analyzed for the same parameters. Field duplicates are collected and analyzed for chemical constituents to measure the precision of the sampling and analysis methods employed. Field duplicates will also be collected and analyzed for field parameters to be performed using field test kits (i.e., alkalinity, carbon dioxide, dissolved oxygen, ferrous iron, hydrogen sulfide, nitrate, and nitrite). The general level of the QC effort will be one field duplicate for every 10 or fewer investigative samples.

Trip blanks and ambient blanks will be submitted for analysis to provide the means to assess the quality of the data resulting from the field sampling program. Ambient blank samples are analyzed to check for interfering contaminants that could potentially be present in ambient air at the sampling site (e.g., volatile compounds in an area where fumes are typically present or metal particulates on a windy day in a dry, dusty area). Ambient blanks are collected at the sampling location(s) by placing analyte-free water directly into the same types of containers, preserved and stored in the same manner, as field samples. The exposure of ambient blanks to ambient conditions should be similar to the ambient exposure of field samples. Ambient blanks will be collected based on conditions at the time of sampling, at the discretion of the Field Operations Leader (FOL), as needed to delineate site conditions. Ambient blanks are also discussed in Section 4.3.5 of the FSP.

Trip blanks pertain to VOCs only. Trip blanks are used to assess the potential for contamination of VOCs resulting from contaminant migration into sample bottles/jars during sample shipment and storage. Trip blanks are prepared by the laboratory using organic-free reagent water prior to the sampling event. They are shipped to the site with the sample containers and kept with the investigative samples throughout the sampling event. They are then packaged for shipment with other VOC environmental samples and sent to the laboratory for analysis. At no time after trip blank preparation are the trip blank sample containers opened before they reach the laboratory. One trip blank will be included in each sample shipping container that contains samples for VOC analysis.

Equipment rinsate blanks are used to assess the effectiveness of decontamination procedures. The use of decontamination procedures is not anticipated because dedicated equipment will be used for well sampling, the installation of new monitoring wells is not planned, and a direct-fill method will be used for collection of spring and surface water samples. Therefore, the collection of equipment rinsate blanks is

not anticipated. When applicable, equipment rinsate blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment (bailer, split-spoon, corer, etc.) after decontamination and then placing the rinse water in the appropriate sample container for analysis. One rinsate blank is collected per each type of non-dedicated sampling equipment used per day that sampling is conducted. Rinsate blanks are analyzed for the same chemical constituents as the associated environmental samples.

The collection of source water blanks is not anticipated because source water blanks are only applicable if decontamination procedures are used in the field. The use of decontamination procedures is not anticipated because dedicated equipment will be used for sampling and the installation of new monitoring wells is not planned. Source water blanks are obtained by sampling the analyte-free water and/or potable water source(s) used for decontamination of sampling equipment. If applicable, source water blanks are used to determine whether the analyte-free water or the potable water (used for steam cleaning) may be contributing to sample contamination. If non-dedicated bailers/bladder pumps are used or if new wells are installed, one source water blank will be collected for each source of water used for decontamination.

MSs are investigative samples analyzed to provide information about the effect of the sample matrix on the digestion and measurement methodology. All MSs for organic analyses are performed in duplicate and, as previously defined, are referred to as MS/MSD samples. One MS or MS/MSD sample will be collected/designated for every 20 or fewer investigative samples. Extra sample volume must be collected for samples designated for MS/MSD analysis for VOCs and extractable organics. Specific details regarding extra sample volume required for MS/MSD samples are provided for each applicable analytical fraction in Table 4-10 of the approved FSP. MS/MSD samples are further discussed in Section 8.0.

Tables 4-11 through 4-16 of the FSP indicate the total number of each QC sample to be collected on the bases of parameter, unit, and sampling event.

4.0 SAMPLING PROCEDURES

Field sampling procedures for the Ground Water Monitoring Plan are discussed in detail in the approved FSP and the SOPs included in Appendix B of the FSP. The FSP addresses sampling procedures and additional field investigation tasks in the following sections and appended SOPs:

- Monitoring Well Locations - Section 3.1
- Monitoring Well Construction Details - Section 3.2
- Surveying - Section 3.3
- Selection of Monitoring Wells and Springs for Sampling and Analysis - Section 4.1
- Inspection of Existing Monitoring Wells - Section 4.2.1 (SOP 1)
- Water-Level Measurements - Section 4.2.2 (SOP 2)
- Low-Flow Pump Installation - Section 4.2.3 (SOP 3)
- Well Purging - Section 4.2.4 (SOP 4)
- Low-Flow Sampling of Monitoring Wells - Section 4.2.5 (SOP 5)
- Sampling of Springs and Little Sulfur Creek - Section 4.2.6 (SOP 6)
- Field Analysis - Section 4.2.7 (SOP 4, SOP 6, SOP 7)
- Decontamination of Field Sampling Equipment - Section 4.2.8 (SOP 8)
- Investigation-Derived Waste Management - Section 4.2.9
- Sample Identification System - Section 4.2.10 (SOP 9)
- Sample Preservation and Handling - Section 4.2.11 (SOP 10)
- Chain-of-Custody/Documentation - Section 4.2.12 (SOP 11)
- Quality Assurance/Quality Control Samples - Section 4.3
- Calibration Procedures and Frequency - Section 4.5
- Performance and System Audits - Section 4.6
- Preventive Maintenance - Section 4.7

5.0 CUSTODY PROCEDURES

Custody is one of several factors that is necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area. A sample or evidence file is under custody under any one of the following conditions:

- The item is in the actual physical possession of an authorized person.
- The item is in view of the person after being in his or her possession.
- The item was placed in a secure area to prevent tampering.
- The item is in a designated and identified secure area with access restricted to authorized personnel only.

The chain-of-custody (COC) report is a multi-part, standardized form used to summarize and document pertinent sample information, such as sample identification and type, matrix, date and time of collection, preservation, and requested analyses. Furthermore, through the sequential signatures of various sample custodians (e.g., sampler, airbill number, laboratory sample custodian), the COC report documents sample custody and tracking. Custody procedures apply to all environmental and associated field QC samples obtained as part of the data collection system.

5.1 FIELD CUSTODY PROCEDURES

The FOL (or designee) is responsible for the care and custody of the samples collected until they are relinquished to the laboratory or entrusted to a commercial overnight courier. COC reports are completed for each sample shipment. The reports are filled out in a legible manner, using waterproof ink, and are signed (and dated) by the sampler. Pertinent notes, such as whether the sample is suspected to be high in contaminant concentration, are also indicated on the COC report. Information similar to that contained in the COC report is also provided on the sample label, which is securely attached to the sample bottle. In addition, sample tags will be affixed to the sample bottles and will be returned by the analytical laboratory for inclusion in the final evidence file. A temperature blank will be included in each cooler. By measuring the temperature of the temperature blank, the internal temperature of the cooler will be measured and recorded in a designated block on the COC prior to sealing the cooler for shipment to the laboratory.

Full details regarding sample COC (including use of custody seals and sample shipment protocols) are contained in SOP 11, which is provided in Appendix B of the approved FSP. SOP 11 also discusses maintenance of site logbooks, site notebooks, and other field records. Additionally, each of the various sampling SOPs incorporated into the FSP contains a section that addresses relevant sample documentation (i.e., completion of sample logsheets, etc.). All sample records are eventually docketed into the Administrative Record at NSWC Crane.

5.2 LABORATORY CUSTODY PROCEDURES

When samples are received by the subcontracted laboratory, the laboratory's sample custodian will examine each cooler's custody seals to verify that they are intact and that the integrity of the environmental samples has been maintained. The custodian will then open the cooler and measure its internal temperature by measuring the temperature of the temperature blank; as previously noted, a temperature blank will be included in each cooler. The temperature reading will be documented by each of the subcontracted laboratories in a designated block on the COC report. The sample custodian will then sign the COC report and examine the contents of the cooler. Sample container breakages or discrepancies between the COC report and sample label documentation will be recorded. With the exception of samples for VOC analysis, the pH of chemically preserved samples will be checked using Hydrion paper and recorded. (The pH of VOC samples will be checked and recorded after analysis to prevent loss of volatile compounds.) A Laucks Testing Laboratories, Inc., CLP Sample Receipt Log and Supplemental Sample Receipt Log, as shown in Appendix 3 of SOP LTL-4002 (Appendix B), will be completed by Laucks Testing Laboratories, Inc. As discussed in Section B of SOP 5.01 (Appendix B), Triangle Laboratories, Inc., will record all sample shipment inspection observations directly into the LIMS. All problems or discrepancies noted during this process are to be promptly reported to the TtNUS Task Order Manager (TOM). Samples are then logged into the laboratory's LIMS. Other pertinent issues relating to sample custody, such as interlaboratory COC procedures and specific procedures for sample handling, storage, dispersement for analysis, and remnant disposal, are discussed in the laboratory SOPs included in Appendix B.

5.3 FINAL EVIDENCE FILES

The Administrative Record at NSWC Crane will be the repository for all documents which constitute evidence relevant to sampling and analysis activities as described in this QAPP. NSWC Crane will be the custodian of the evidence file and will maintain the contents of these files, including all relevant records,

reports, logs, field notebooks, pictures, subcontractor reports, and data reviews in a secure, limited access location and under custody of the NSWC Crane Facility Permit Manager. The control file will include at a minimum:

- Field logbooks
- Field data and data deliverables
- Photographs and negatives
- Drawings
- Laboratory data deliverables
- Data validation reports
- Data assessment reports
- Progress reports, Quality Assurance (QA) reports, interim project reports, etc.
- All custody documentation (tags, forms, airbills, etc.)

Upon completion of the contract, all files associated with this ground water program will be maintained in the Administrative Record at NSWC Crane and will be available for inspection by the regulatory agencies.

6.0 CALIBRATION PROCEDURES AND FREQUENCY

All instrumentation used to perform chemical measurements must be properly calibrated prior to use in order to obtain valid and usable results. The requirement to properly calibrate instruments prior to use applies equally to field instruments as it does to fixed laboratory instruments. Field instrument calibration is discussed in Section 6.1. Laboratory instrument calibration is discussed in Section 6.2.

6.1 FIELD INSTRUMENT CALIBRATION

Field instrument calibration is discussed in Section 4.5 of the approved FSP.

6.2 LABORATORY INSTRUMENT CALIBRATION

Calibration procedures for a specific laboratory instrument will consist of initial calibration (generally three to five points), initial calibration verification (inorganic methods only), and continuing calibration verification. In all cases, an independently prepared standard (i.e., from a second source or a different lot number from the primary source) will be used as a calibration verification solution or as the LCS/MS spiking mix.

All standards used to calibrate analytical instruments must be obtained from the National Institute of Standards and Technology (NIST) or through a reliable commercial supplier with a proven record for quality standards. All commercially supplied standards will be traceable to NIST reference standards, where possible, and appropriate documentation will be obtained from the supplier. In cases where documentation is not available, the laboratory will analyze the standard and compare the results to an U.S. EPA-known or previous NIST-traceable standard.

Sources of certified standards could not be located for two (TNX and MNX) of the seven explosives degradation products discussed in Section 1.4.2.2. Two sources (Army Environmental Center and Stanford Research) of uncertified standards were located for TNX. A single source (Stanford Research) of uncertified standard was located for MNX; however, a second source of reliable standard could not be located for this compound. (An additional source, Army Environmental Center, of uncertified standard was located for MNX; however, this standard was found to be unstable when analyzed and, therefore, cannot be used.) It should be noted, however, that analysis for explosives degradation products will only be performed for some of the samples collected from the ABG, and the results for these compounds will be

be used only in the evaluation of natural attenuation, unless they are identified and become part of the compliance monitoring program. A note will be added to data package case narratives in cases when an uncertified standard is used or when a second, independently prepared standard is not used. Each of the explosives compounds will be included in the MS and LCS analyses.

Calibration procedures, frequency requirements, acceptance criteria, and conditions that require recalibration are described for each analytical procedure in the applicable laboratory SOPs included in Appendix B.

7.0 ANALYTICAL AND MEASUREMENT PROCEDURES

With the exception of samples collected for dioxin/furan and dissolved methane, ethane, and ethene analyses, all ground water samples collected as part of the NSWC Crane ground water monitoring program will be analyzed by Laucks Testing Laboratories, Inc., 940 South Harney Street, Seattle, Washington 98108; (206) 767-5060; FAX (206) 767-5063. Analysis for dioxins/furans will be performed by Triangle Laboratories, Inc., 801 Capitola Drive, Durham, NC 27713; (919) 544-5729; FAX (919) 544-5491. These laboratories have successfully completed the laboratory evaluation process required as part of the NFESC QA Program and described in the "Navy Installation Restoration Laboratory Quality Assurance Guide" (NFESC, February 1996). Dissolved methane, ethane, and ethene analyses will be performed by Microseeps, Inc., University of Pittsburgh Applied Research Center, 220 William Pitt Way, Pittsburgh, PA 15238; (412) 826-5245; Fax (412) 826-3433.

Field measurements and analytical procedures are discussed in detail in the remainder of this section.

7.1 FIELD MEASUREMENT PROCEDURES

Chemical/physical parameters to be measured using field instrumentation include temperature, specific conductance, pH, dissolved oxygen, ORP, turbidity, and water level. HACH test kits will be used for the measurement of alkalinity (bicarbonate, carbonate, and hydroxide), carbon dioxide, ferrous iron, hydrogen sulfide, nitrate, and nitrite. Measurement of dissolved oxygen for samples collected to evaluate natural attenuation will also be performed using a HACH test kit. Measurement of field parameters is discussed in Section 4.2.7 of the approved FSP. Calibration of field instruments is discussed in Section 4.5 of the approved FSP.

7.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES

Table 7-1 provides a summary of the laboratory analytical methods and associated laboratory SOPs to be used during the ground water monitoring program. Laboratory SOPs for these analyses are included in Appendix B of the QAPP.

7.2.1 List of Project Target Compounds and Detection Limits

A complete list of the target compounds/analytes; project-specific risk-based target levels; and laboratory-specific MDLs (all parameters except metals), IDLs (metals only), and RLs is provided in Section 1.4 of this QAPP. The MDLs shown have been experimentally determined using the procedures described in Section 6.3 of Laucks Testing Laboratories, Inc., SOP LTL-1011 and in Triangle Laboratories, Inc., SOP CQA125, which are included in Appendix B of the QAPP. These procedures are based on the method provided in 40 CFR Part 136 Appendix B (FR Vol. 49, No. 209, pages 198-199). The MDLs provided for dissolved methane, ethane, and ethene were also determined using the method provided in 40 CFR Part 136 Appendix B by Microseeps, Inc. The IDLs provided for metals have been experimentally determined as described in Section 6.2.6 of Laucks Testing Laboratories, Inc., SOP LTL-1011. This procedure is based on the procedure for IDL determination as specified in the U.S. EPA Contract Laboratory Program (CLP) (ILM04.0; U.S. EPA, 1995). All environmental data will be reported to lower of the analyte's RL as specified in Table 1-3 or the lowest calibration standard used for that analyte. An analyte's RL is based on the associated MDL/IDL with adjustments made to ensure that the precision and accuracy requirements of the method are attainable. RLs will be adjusted on a sample-by-sample basis, as necessary, based on dilutions and sample volume. These adjusted values are known as sample quantitation limits (SQLs).

7.2.2 List of Associated Quality Control Samples

In addition to the field QC samples (field duplicates, trip blanks, rinsate blanks, etc.) discussed in Section 3.0 of this QAPP, laboratory QC samples, including method blanks, preparation blanks, LCSs, etc., will be analyzed. Laboratory QC samples are discussed in detail in Section 8.0 of this QAPP. The analytical SOPs included in Appendix B address minimum QC requirements for each of the associated analytical methods.

TABLE 7-1

**SUMMARY OF ORGANIC AND INORGANIC ANALYTICAL PROCEDURES
GROUND WATER SAMPLES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 2**

Analytical Parameter	Preparation Method	Analytical Method	Preparation/Analytical SOP(s) [1]
Explosives	SW-846[2] 8330	SW-846 8330	LTL-3077 / LTL-8330
Nitrocellulose	Modified Army Corps Method[3]	Modified Army Corps Method	LTL-9132 / LTL 9125
Picric acid and Picramic Acid	Laucks HPLC Method	Laucks HPLC Method	LTL-3550 / LTL-8303
Appendix IX Metals (except mercury) – total	SW-846 3010A or SW-846 3015	SW-846 6020	LTL-7009 or LTL-7010 / LTL-7202
Appendix IX Metals (except mercury) – dissolved	---[4]	SW-846 6020	LTL-7202
Mercury - total & dissolved	SW-846 7470A	SW-846 7470A	LTL-7501
Iron, Manganese - total	SW-846 3010A or SW-846 3015	SW-846 6010B	LTL-7009 or LTL-7010 / LTL-7102
Calcium, Magnesium, Manganese, Potassium, and Sodium – dissolved	---	SW-846 6010B	LTL-7102
Appendix IX Volatile Organic Compounds[5]	SW-846 5030A	SW-846 8260B (with 25 mL purge)	LTL-8265 (low-level option)
1,4-Dioxane, Acetonitrile, Isobutyl alcohol, and Propionitrile	SW-846 5030A	SW-846 8015B	LTL-8019
Appendix IX Semivolatile Organic Compounds	SW-846 3520C	SW-846 8270C	LTL-3000 / LTL-8276
Polynuclear Aromatic Hydrocarbons	SW-846 3520C	SW-846 8270C with SIM	LTL-3000 / LTL-8277
Appendix IX Organochlorine Pesticides and PCBs	SW-846 3510C	SW-846 8081	LTL-3202 / LTL-8081
Appendix IX Herbicides	SW-846 8151A	SW-846 8151A	LTL-8151
Dioxins/Furans	SW-846 8290	SW-846 8290	DSP161/ DHR182
Ammonia	---	EPA[6] 350.1	LTL-9109
Chloride	---	SW-846 9056	LTL-9110
Cyanide	---	SW-846 9012A	LTL-9104

TABLE 7-1

SUMMARY OF ORGANIC AND INORGANIC ANALYTICAL PROCEDURES
GROUND WATER SAMPLES
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 2

Analytical Parameter	Preparation Method	Analytical Method	Preparation/Analytical SOP(s) [1]
Dissolved Methane, Ethane, and Ethene	Microseeps, Inc., GC Method	Microseeps, Inc., GC Method	AM18.01
Phosphorus (Total and Dissolved)	---	EPA 365.2	LTL-9108
Sulfate	---	SW-846 9056	LTL-9110
Sulfide	SW-846 9030B	SW-846 9034	LTL-9205
Total Organic Halides	---	SW-846 9020B	LTL-9119

1 Laboratory SOPs are included in Appendix B.
2 U.S. EPA, 1986b. Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods. SW-846, 3rd Ed. And subsequent updates.
3 Indiana Army Ammunition Plant Contamination Survey. "Nitrocellulose in Water". Aqualab, Inc., 1983.
4 No preparation method is required for this parameter.
5 These methods and the associated laboratory SOP are also applicable for the analysis of the aromatic and chlorinated hydrocarbons (listed in footnote 8 of Table 1-1) for the quarterly monitoring program at the ABG.
6 U.S. EPA, 1983. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020.

8.0 INTERNAL QUALITY CONTROL CHECKS

Field-related QC checks are discussed in Section 3.0 of this QAPP and in Section 4.3 of the approved FSP. This section provides additional information regarding internal QC checks for the field and the laboratory.

8.1 FIELD QUALITY CONTROL CHECKS

Internal QC procedures for pH, specific conductance, temperature, dissolved oxygen, ORP, and turbidity will include calibrating the instruments as described in Section 4.5 of the approved FSP. Internal QC procedures for alkalinity, dissolved oxygen (for natural attenuation samples), nitrate, nitrite, and hydrogen sulfide are described in SOP 7 (Appendix B of the approved FSP) and the HACH procedures included in Appendix C of the FSP. Assessment of field sampling precision and bias will be made by collection of field duplicates for laboratory analysis. Collection of field QC samples will be in accordance with the procedures provided in Section 4.3 of the FSP at the frequencies indicated in Tables 4-11 through 4-16 of the FSP.

8.2 LABORATORY QUALITY CONTROL CHECKS

The identified subcontract laboratories have QC programs that ensure the reliability and validity of the analyses performed at the laboratories. Each laboratory maintains a QA Plan which describes the policies, organization, objectives, QC activities, and specific QA functions employed by the laboratory. All analytical procedures are documented in writing as SOPs. Each analytical SOP specifies minimum QC requirements for the procedure. As previously noted, SOPs for all analyses to be performed during the ground water monitoring program are included in Appendix B of the QAPP. Table 7-1 provides a list of the SOPs associated with each analytical procedure. In addition, the laboratories maintain SOPs regarding general laboratory QA procedures. Several of these SOPs, as applicable, are also included in Appendix B. The Table of Contents included in Appendix B provides a list of SOP titles and associated SOP numbers for all SOPs contained in the appendix.

Several internal laboratory QC checks are briefly discussed in the remainder of this section. Additional QC requirements which are specific to the NFESC QA Program, and are therefore requirements for this project, are also specified, as applicable, for each of the QC checks.

Laboratory method blanks are prepared and analyzed in accordance with the analytical method employed to determine whether contaminants originating from laboratory sources have been introduced and have affected environmental sample analyses. Method blanks for analytical methods which include preparative extraction or digestion procedures are also called preparation blanks. A method blank for ground water sample analysis generally consists of an aliquot of analyte-free water that is subjected to the same preparation and analysis procedures as the environmental samples undergoing analysis. Criteria for method blanks and corrective actions for noncompliant results are described in each of the SOPs for determinative analysis in Appendix B. Under no circumstances are laboratory method blank contaminant values subtracted from environmental sample analysis results.

Matrix spike analysis for organic fraction analyses will be performed in duplicate (i.e., MS/MSD analysis) with a frequency of 1 per 20 environmental samples as a measure of laboratory precision. (As noted in Sections 3.1.3 and 3.2.3, MS/MSD analysis is not applicable for dissolved methane, ethane, and ethene analyses.) For inorganic analyses, MS and **laboratory duplicate** analysis will be performed for every 20 environmental samples. Laboratory duplicates are prepared by obtaining two sample aliquots from the same sample container and analyzing each portion following the same analytical procedures. For volatile and extractable organic MSD analyses, a sample aliquot from a separate sample container is used for analysis. As discussed in detail in Section 3.6 of the QAPP, the field crew will provide extra volumes of sample matrices designated for laboratory QC analyses, as required.

Based on NFESC requirements, MS samples should contain all the targeted analytes of interest. However, because of the extensive list of compounds included on the Appendix IX list for volatile, semivolatile, and pesticide/PCB organic compounds and the overlapping retention times of some of these compounds, it is not feasible to spike and analyze for the full list of Appendix IX compounds in the MS/MSD samples. Therefore, MS/MSD samples for these fractions will be spiked with a representative list of these chemicals. Tables specifying matrix spiking compounds per analytical method and associated statistical laboratory control limits to be used for the ground water monitoring program are provided in Section 3.

If the MS recovery is not within applicable control limits, the laboratory will assess the batch to determine whether the spike results are attributable to a matrix effect or are the result of other problems in the analytical process. Based on NFESC requirements, if all the batch QC elements which are not affected by the sample matrix are in control (e.g., method blank, LCS, calibration checks) and if there is no evidence that spiking was not properly performed, the poor spike recovery may be attributed to matrix effects. In

this case, the failed MS will be discussed in the case narrative, but re-preparation and re-analysis is not required. If any of the batch QC elements which are not affected by the sample matrix are out of control, or if there is any evidence that spiking may have been improperly performed, the MS and/or MSD sample will be re-processed through the entire analytical sequence unless insufficient sample is available. Discussion of noncompliant MS/MSD and laboratory duplicate results will be included in the SDG narrative.

Surrogates are organic compounds (typically brominated, fluorinated, or isotopically labeled) which are similar in nature to the compounds of concern, and which are not likely to be present in environmental media. Surrogates are spiked into each sample, standard, and method blank prior to analysis, and, with the exceptions of dissolved methane, ethane, and ethene and dioxin/furan analyses, are used in organic chromatographic analysis procedures as a check of method effectiveness. Surrogate recoveries will be evaluated against the laboratory-derived statistical control limits presented in Section 3.0. Corrective actions for noncompliant surrogate recoveries are discussed in the relevant determinative SOPs included in Appendix B. Discussion of noncompliant surrogate recoveries will be included in the SDG narrative.

Laboratory control samples or blank spike samples serve to monitor the overall performance of each step during the analysis, including the sample preparation. LCSs must be included in each preparation or analytical batch of 20 samples or less, and must be analyzed utilizing the same sample preparations, analytical methods, and QA/QC procedures as those employed for the samples. Based on the requirements of the NFESC QA Program, LCSs for wet chemistry and metals analyses must contain all analytes of interest, whereas LCSs for multiple-analyte organic methods must contain at least two targeted analytes from each major class of compounds subject to analysis. (For example, a semivolatile organic LCS must contain at least six analytes, including two basic, two neutral, and two acidic compounds.) Since, in addition to metals, the analytes of primary concern at NSWC Crane are explosives, the complete target analyte list of explosives (based on the target analyte list of the samples being analyzed at the time) will be included in the LCSs associated with explosives analysis. The complete target analyte list of PAHs and dioxins/furans will also be included in the LCSs for these analyses. The spiking lists for volatile, semivolatile, pesticide/PCB, and herbicide analyses will contain analytes which represent each of the various classes of analytes on the target analyte list. LCS analysis is not applicable for dissolved methane, ethane, or ethene analyses. LCS results will be evaluated against the control limits statistically established by the laboratory. Tables specifying LCS spiking compounds per analytical method and associated statistical laboratory control limits to be used for the ground water monitoring program are provided in Section 3.0.

Based on NFESC QA Program requirements, if recovery of a LCS falls outside the control limits, the laboratory will reject the data for the analytical batch and take corrective action. The associated samples, extracts, or digestates may be reanalyzed a single time, and if the LCS recoveries meet acceptance criteria, the data will be reported. If LCS analyte recovery is still outside the acceptance limits, the associated samples in the preparation batch will be reprocessed if sufficient sample is available and holding times have not elapsed. If repreparation or reanalysis is not possible, the SDG narrative will include a discussion of the failed LCS.

Internal standard performance criteria ensure that gas chromatography/mass spectrometry (GC/MS) analysis sensitivity and response are stable during every analytical run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (- 50% to + 100%) from the associated 12-hour calibration standard. The retention time of the internal standards in samples and blanks must not vary by more than ±30 seconds from the retention time of the associated 12-hour calibration standard.

Additional internal laboratory QC checks include mass tuning for GC/MS analysis, second-column confirmation for GC analysis (excluding dissolved methane, ethane, and ethene analyses), and endrin/DDT degradation checks for pesticide analysis. Specific QC requirements for each of these QC checks are provided in the applicable SOPs included in Appendix B of this QAPP.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

This section describes the procedures to be used for data reduction, validation, and reporting for the ground water monitoring program for NSWC Crane. All data generated during the course of the ground water monitoring program will be maintained in hard copy form in the Administrative Record at NSWC Crane.

9.1 DATA REDUCTION

Data reduction will be completed for both field measurements and laboratory-generated analytical data. Field data reduction will be relatively limited versus the degree of laboratory data reduction required for the project. Reduction of both field data and laboratory data are discussed in the remainder of this section.

9.1.1 Field Data Reduction

Field data will be generated through onsite water quality testing for general indicator parameters, including pH, specific conductance, turbidity, dissolved oxygen, ORP, and temperature, using direct-read instrumentation (meters). No calculations will be necessary to reduce these data. Measurements of ferrous iron, alkalinity (bicarbonate, carbonate, and hydroxide), dissolved oxygen (for natural attenuation samples), nitrate, nitrite, and hydrogen sulfide will be performed using HACH field test kits. Data reduction for these parameters is described in the HACH procedures included in Appendix C of the approved FSP. Field measurements will be recorded on sample logsheets immediately after measurements are taken. If an error is made in the field records, the error will be legibly crossed out (single-line strikeout), initialed and dated by the field member, and corrected in a space adjacent to the original (erroneous) entry. Further information regarding field documentation is provided in SOP 11, which is included in Appendix B of the approved FSP. The field measurements will later be encoded into the NSWC Crane database. Field data will be entered in the electronic database manually, and the entries will be verified by an independent reviewer to ensure that no transcription errors occurred. Field measurements will be recorded and reported in the following units:

- pH - standard pH units
- Temperature - degrees Celsius
- Specific conductance - millimhos
- Turbidity - Nephelometric turbidity units (NTU)

- Dissolved oxygen - milligrams per liter (mg/L)
- Alkalinity (mg/L)
- Hydrogen Sulfide (mg/L)
- ORP - millivolts (mV)
- Ferrous iron (mg/L)
- Nitrate (mg/L)
- Nitrite (mg/L)
- Water level - feet (ft)

9.1.2 Laboratory Data Reduction

Data reduction will be completed by the subcontracted laboratories in accordance with the method-specific laboratory SOPs included in Appendix B. In addition, SOP LTL-1018 (provided in Appendix B) presents the procedures used by Laucks Testing Laboratories, Inc., for review and approval of data.

It should be noted that a limited number of explosive compounds (e.g. 2-, 3-, and 4-nitrotoluenes; or 2,4- and 2,6-dinitrotoluenes; and 1,3,5-trinitrobenzene and 1,3-dinitrobenzene) coelute on the confirmation column. However, these compounds do not coelute on the primary column. Quantitation will be performed using the primary column. Therefore, if only one of the coeluting compounds is detected on the primary column [and not the compound(s) it coelutes with], coelution on the confirmation column has no impact. The only potential for uncertainty is in the unlikely case that more than one of the coeluting compounds is detected on the primary column and a peak is also present in the expected retention time window on the confirmation column. In this case, it would not be possible to determine which compound(s) were actually present. Therefore, as a conservative measure, both compounds will be assumed to be present, and both will be quantitated and reported from the primary column. If this occurs, the results for these compounds will be reported by the laboratory with a "Z" flag to indicate coelution has occurred on the confirmation column and that quantitative confirmation is not possible.

In addition, although analyses for the compound pairs HMX and 2,6-diamino-4-nitrotoluene and for 3,5-dinitroaniline and tetryl will be performed using separate runs and different columns, the possibility of coelution exists for these compound pairs on the primary column used for analysis of HMX and tetryl. However, these compound pairs do not coelute on the confirmation column used for analysis of HMX and tetryl. In addition, the two pairs of compounds do not coelute on either of the columns used for the analysis of 2,6-diamino-4-nitrotoluene and 3,5-dinitroaniline. Therefore, the presence or absence of HMX

and tetryl can be definitely confirmed. If this situation arises and interfering peaks are present on the primary column for the analysis of HMX and tetryl, results for these compounds will be quantitated and reported from the confirmation column, and the laboratory will document this in the case narrative. No qualifying flags will be reported with the results.

Laboratory analytical data will be reported using standard concentration units to ensure comparability with previous analytical results. Reporting units for the various classes of chemicals under consideration are as follows:

- Explosives - micrograms per liter (µg/L)
- Metals - µg/L
- Volatile organic compounds - µg/L
- Semivolatile organic compounds - µg/L
- Organochlorine pesticides/PCBs - µg/L
- Organophosphorus pesticides - µg/L
- Herbicides - µg/L
- Dioxins/furans - picograms per liter (pg/L)
- Ammonia - mg/L
- Chloride - mg/L
- Cyanide - mg/L
- Dissolved ethane - nanograms per liter (ng/L)
- Dissolved ethene - ng/L
- Dissolved methane - ng/L
- Phosphorus - mg/L
- Sulfate - mg/L
- Sulfide - mg/L
- TOC - mg/L
- TOX - mg/L

9.2 DATA VALIDATION

Validation of field measurements and laboratory analytical data are discussed in this section. Validation of field data will be limited to real time "reality" checks, whereas laboratory analytical data will be validated in

accordance with current U.S. EPA guidance. Validation of field measurements is discussed in Section 9.2.1. Validation of laboratory analytical data is discussed in Section 9.2.2.

9.2.1 Procedures Used to Evaluate Field Data

Field measurements will not be subjected to a formal data validation process. However, field technicians will ensure that the equipment used for field measurement is performing accurately via compliance with the applicable SOPs. As described in Section 9.1.1, all field data entered into the electronic database will be independently reviewed for transcription errors.

9.2.2 Procedures Used to Validate Laboratory Data

One hundred percent of the laboratory analytical data will be subjected to data validation to ensure that the data are of evidentiary quality prior to statistical evaluation of the data. Validation of analytical data will be completed by the TtNUS Chemistry/Toxicology Department located in TtNUS's Pittsburgh office. The data validators will check that the data were obtained through use of the approved methodology, that the appropriate level of QC effort and reporting was conducted, and that the results are in conformance with QC criteria. On the basis of these factors, the data validator will generate a report describing data limitations, which will be reviewed and approved internally by the Data Validation Coordinator prior to submittal to the TOM.

Analytical results will be validated versus the applicable analytical methods, the SOPs included in Appendix B, and the requirements of this QAPP. Validation of these data, including the use of qualifying flags, will conform to the Region 5 Standard Operating Procedures for Validation of CLP Organic and Inorganic Data (U.S. EPA Region 5, 1993a, 1993b) and the National Functional Guidelines for Organic and Inorganic Data Review (U.S. EPA, 1994a, 1994b) to the greatest extent practicable for non-CLP data.

As discussed in Section 9.1.2 of the QAPP, a limited number of explosive compounds (e.g. 2-, 3-, and 4-nitrotoluenes; 2,4- and 2,6-dinitrotoluenes; and 1,3,5-trinitrobenzene and 1,3-dinitrobenzene) coelute on the confirmation column used for analysis. Section 9.1.2 indicated that if more than one of the coeluting compounds is detected on the primary column and a peak is also present in the expected retention time window on the confirmation column, as a conservative measure, both compounds will be quantitated and reported by the laboratory from the primary column. If this occurs, the results for these compounds will be qualified as presumptively present at an estimated concentration ("JN") during data validation.

9.3 DATA REPORTING

This section discusses data reporting requirements for field and laboratory analytical data. Section 9.3.1 discusses field measurement data handling and reporting. Section 9.3.2 discusses laboratory data handling and reporting.

9.3.1 Field Data Reporting

Field data will be reported in the units discussed in Section 9.1.1. Documentation of field activities is described in SOP 11, which is included in Appendix B of the approved FSP. Field measurements will be transferred from the field log sheets to the electronic database manually and will be reviewed for accuracy by an independent reviewer. Quarterly and semi-annual ground water monitoring reports may include brief summaries of field data results if they are indicative of the presence of contamination (e.g., high specific conductance readings) or if trends in ground water quality are noted.

All records regarding field measurements will be placed in the TtNUS central files upon completion of the field effort. Entry of these results in the database will require removal of these records from the files. Outcards will be used to document the removal of any such documentation from the files (date, person, subject matter). After database entry is complete, all records will be copied for placement in TtNUS central files; all original records will be sent to NSWC Crane for inclusion in the final evidence files, as described in Section 5.3.

9.3.2 Laboratory Data Reporting

Data reported by each laboratory for all analytical fractions will be in a CLP-type reporting format. All pertinent QC data including raw data and summary forms for blanks, standards analysis, calibration information, etc., will be provided for all analyses. Case narratives will be provided for each Sample Delivery Group (SDG). As previously discussed in Section 6.2, a note will be added to the case narrative when an uncertified standard is used or when an independently prepared standard (i.e., from a second source or a different lot number from the primary source) is not used due to lack of availability. SOP LTL-4201 (Appendix B) provides further detail regarding the information that will be included in CLP-type packages produced by Laucks Testing Laboratories, Inc.

Data will be handled electronically pursuant to the electronic deliverable requirements specified in TtNUS's Basic Ordering Agreement with analytical laboratories. This agreement requires the analytical

laboratories to provide data in both hardcopy and electronic form. The database will include pertinent sampling information such as sample number, sampling date, and general location. Sample-specific quantitation limits will be reported for nondetected analytes. Units will be clearly summarized in the database and will conform to those identified in Section 9.1.2. The original electronic diskettes and data validation reports for the NSWC Crane ground water monitoring program will be maintained in the Administrative Record at NSWC Crane; copies will be maintained in TtNUS central files. SOP CT-05 discusses database management and QA and is included in Appendix B.

Validation will be completed using the hard copy data. Upon completion of validation of a SDG and review by the Data Validation Coordinator, the validation qualifiers will be entered in the electronic database and will be subjected to independent review for accuracy. During this review process, the electronic database printout will also be compared with the hard copy data to ensure that the hard copy data and electronic data are consistent.

Statistical analysis and reporting of the analytical data in quarterly and semi-annual reports will be performed as described in Section 10.0 of the approved RCRA Ground Water Monitoring Plan.

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits will be performed periodically to ensure that work is being implemented in accordance with the approved project plans and in an overall satisfactory manner. Some examples of pertinent audits are as follows:

- The FOL will supervise and check daily that the field measurements are made accurately, equipment is thoroughly decontaminated, samples are collected and handled properly, and fieldwork is documented accurately and neatly.

- The TOM will maintain contact with the FOL and Data Validation Coordinator to ensure that management of the acquired data proceeds in an organized and expeditious manner.

Details regarding additional audit responsibilities, frequency, and procedures are discussed in the remainder of this section. Field performance and system audits are discussed in Section 10.1. Laboratory performance and system audits are discussed in Section 10.2.

10.1 FIELD PERFORMANCE AND SYSTEM AUDITS

This section discusses the responsibilities, frequencies, and procedures associated with internal and external field performance and system audits.

10.1.1 Internal Field Audits

10.1.1.1 Internal Field Audit Responsibilities

In addition to the daily checks performed by the FOL, an independent performance and system audit of field activities will be conducted by the TtNUS Quality Assurance Manager (QAM) or designee. When the formal field audit is conducted, the QAM (or designee) will be responsible for ensuring that sample collection, handling, and shipping protocols, as well as equipment decontamination and field documentation procedures, are being performed in accordance with the approved project plans and SOPs.

10.1.1.2 Internal Field Audit Frequency

Internal field audits will be conducted once during the first year of the project and then on a semi-annual basis thereafter.

10.1.1.3 Internal Field Audit Procedures

Field audits will be conducted in accordance with the following procedures:

- Prior to the audit, the auditor will prepare a detailed checklist to be used as an auditing guide. An example audit checklist is provided in Appendix C.
- Upon arrival at the audit location, the auditor shall conduct a pre-audit meeting with the responsible management of the organization or project to be reviewed.
- Field audits will include a review of required project documentation (logbooks, sample log sheets, etc.) and field operations (ground water sampling, sample handling, etc.) to evaluate completeness and compliance with applicable SOPs.
- The audit checklist will be used to record observations including any noted nonconformances.
- A formal post-audit debriefing will be conducted, and potential immediate corrective actions will be discussed.
- The auditor will generate a formal audit report which will address corrective actions. This report will be provided by the auditor to the TOM.
- The TOM will ensure that all corrective actions are addressed and will provide written verification of corrective action implementation to the auditor.
- The auditor will manage corrective action verification and audit closure.
- The following audit records will be maintained by the QAM:
  - Audit checklists
  - Audit reports

- Response evaluations
- Verification of corrective actions
- Follow-up checklists and audit reports

10.1.2 External Field Audits

10.1.2.1 External Field Audit Responsibilities

External field audits may be conducted by the IDEM, the U.S. EPA Region 5, or both.

10.1.2.2 External Field Audit Frequency

External field audits may be conducted at any time during field activities at the discretion of the IDEM and U.S. EPA Region 5.

10.1.2.3 Overview of the External Field Audit Process

External audit procedures are at the discretion of U.S. EPA Region 5 and the IDEM.

10.2 LABORATORY PERFORMANCE AND SYSTEMS AUDITS

This section discusses the responsibilities, frequencies, and procedures associated with internal and external laboratory performance and system audits.

10.2.1 Internal Laboratory Audits

10.2.1.1 Internal Laboratory Audit Responsibilities

The QA/QC Officer or appropriate designee of each of the subcontracted laboratories performs routine internal audits of the laboratory. Internal laboratory audits are also conducted by the U.S. Navy. TtNUS holds no responsibility for such audits. Performance and system audits of laboratories are coordinated through the NFESC by an independent QA contractor. It is the responsibility of the NFESC and its contractor to ensure that the subcontracted laboratories comply with good laboratory practices and the general requirements of all analytical services provided by the laboratory.

10.2.1.2 Internal Laboratory Audit Frequency

At a minimum, each of the subcontracted laboratories conducts internal system audits of each laboratory analytical department on an annual basis. Internal audits are performed bi-annually at Laucks Testing Laboratories, Inc., if no external audits are conducted. In addition, each laboratory department at Laucks Testing Laboratories, Inc., analyzes blind performance evaluation (PE) samples as described in SOP LTL-1009 (Appendix B). Data audits are also performed by the Laucks Testing Laboratory QA/QC Officer at a minimum frequency of once per year for each analytical area.

Each laboratory section is audited at least once per quarter at Triangle Laboratories, Inc. As described in SOP 2.02 (Appendix B), these audits may consist of traceability audits, phase inspections, data audits, and/or documentation inspections.

Each laboratory section is audited at least once per year at Microseeps, Inc.

Internal laboratory performance and system audits are completed by the U.S. Navy for each contracted laboratory in the NFESC QA Program on an 18-month schedule.

10.2.1.3 Internal Laboratory Audit Procedures

Internal systems audits are conducted to detect any problems in sample flow, analytical procedures, or documentation and to ensure adherence to laboratory SOPs. Laucks Testing Laboratories, Inc., internal audit procedures are described in SOP LTL-1017 (Appendix B). Triangle Laboratories, Inc., internal audit procedures are described in SOP 2.02 (Appendix B). Microseeps, Inc., audits involve the preparation of an audit plan by the QA Manager. The audit plan delineates the activities and records to be reviewed. The Laboratory Director is consulted to ensure that all areas of concern are addressed. The audit is performed following the prepared plan. Notes are made based upon observations, interviews, and record reviews. An audit report is prepared following the audit. This report is forwarded to the Laboratory Director for review and discussion. If deficiencies are noted, follow-up is conducted to monitor the effectiveness of corrective action.

Internal U.S. Navy laboratory audit procedures, as performed by a Navy contractor, include a pre-screening process which requires review of the laboratory's QA manual, analysis of PE samples, generation of data deliverables for the PE samples, an onsite technical systems audit of the laboratory, and satisfactory resolution of all deficiencies and findings.

10.2.2 EXTERNAL LABORATORY AUDITS

10.2.2.1 External Laboratory Audit Responsibilities

An external audit may be performed by the IDEM and is being conducted by U.S. EPA Region 5 for Laucks Testing Laboratory. Each laboratory is also involved in external audits and performance evaluation studies throughout the year, as required, to maintain certifications and/or approvals by other regulatory agencies or programs.

10.2.2.2 External Laboratory Audit Frequency

An external laboratory audit may be conducted by U.S. EPA Region 5 or IDEM prior to or during sampling and analysis activities.

10.2.2.3 Overview of the External Laboratory Audit Process

External audit procedures are at the discretion of U.S. EPA Region 5 and the IDEM. External laboratory audits may include (but are not limited to) review of laboratory analytical procedures, laboratory onsite audits, and/or submission of PE samples to the laboratory for analysis.

11.0 PREVENTIVE MAINTENANCE PROCEDURES

Measuring equipment used in environmental monitoring or analysis for the NSWC Crane ground water monitoring program will be maintained in accordance with the manufacturer's operation and maintenance manuals. Equipment and instruments will be calibrated in accordance with the procedures and at the frequency discussed in Section 6.0 (Calibration Procedures and Frequency). Preventive maintenance for field and laboratory equipment are discussed in the remainder of this section.

11.1 FIELD EQUIPMENT PREVENTIVE MAINTENANCE

Preventive maintenance of field equipment is discussed in Section 4.7 of the approved FSP.

11.2 LABORATORY INSTRUMENT PREVENTIVE MAINTENANCE

Proper maintenance of laboratory instruments and equipment is essential to ensuring their readiness when needed. Dependent on manufacturer's recommendations, maintenance intervals are established for each instrument. All instruments will be labeled with a model number and serial number, and a maintenance logbook will be maintained for each instrument. Personnel will be alert to the maintenance status of the equipment they are using at all times. Table 11-1 provides a summary of preventive maintenance procedures performed by Laucks Testing Laboratories, Inc., and Triangle Laboratories, Inc., for key analytical instruments and equipment.

The use of manufacturer-recommended grades or better of supporting supplies and reagents is also a form of preventive maintenance. For example, gases used in the various gas chromatographs and metals instruments are of sufficient grade to minimize fouling of the instrument. The routine use of septa, chromatographic columns, and other supporting supplies from reputable manufacturers will assist in averting unnecessary periods of instrument downtime. An inventory of critical spare parts will also be maintained by the laboratory to minimize instrument downtime.

TABLE 11-1

**PREVENTIVE MAINTENANCE FOR ANALYTICAL INSTRUMENTS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 1 OF 4**

Instrument	Laboratory	Preventive Maintenance	Maintenance Frequency
GC/MS - Volatiles	Laucks Testing Laboratories	Change pump oil.	Yearly.
		Clean and rinse transfer lines, trim front end of column; rinse 6-port valve, clean or replace sample lines, replace trap, replace column, clean source, replace fittings, change sample block on autosampler, replace filaments.	As needed.
GC/MS - Semivolatiles	Laucks Testing Laboratories	Change injection port liner and septum, clip 5-10 cm from front of pre-column, ramp GC oven twice to 310 C.	Daily or as needed.
		Clean source, install new guard column, clean or replace tubing, replace bottom seal in injection port, replace o-ring in injection port.	As needed.
HRGC/VG HRMS - Dioxins/Furans	Triangle Laboratories	Inspect vacuum system pressures, inspect helium tank pressures and change if less than 300 psi.	Daily.
		Change injection port liner and septum.	As needed.
		Inspect water filters and change if necessary.	Monthly.
		Bake AutoSpec flight tube.	Bi-monthly.
		Clean ion source, change reservoir septum.	Quarterly or as needed.
		Clean source slit, clean or replace split line, inspect focus 2 assembly and clean if necessary, bake out 70 style HRMS, replace rotary pump oil, check diffusion pump oil and add if needed.	Bi-annually or as needed.
		Change oxygen trap.	Annually.
		Full preventive maintenance visit by an engineer.	As needed.
GC - Volatiles by purge and trap (i.e., 1,4-dioxane, acetonitrile, isobutyl alcohol, propionitrile)	Laucks Testing Laboratories	Change carrier and make-up gas filters.	As needed.
		Change trap, clean flame ionization detector (FID) jet, trim column.	As needed.

TABLE 11-1

**PREVENTIVE MAINTENANCE FOR ANALYTICAL INSTRUMENTS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 2 OF 4**

Instrument	Laboratory	Preventive Maintenance	Maintenance Frequency
GC – Organochlorine pesticides/PCBs, herbicides	Laucks Testing Laboratories	Swab electron capture (EC) detectors for radioactivity.	Semi-annually.
		Change O_2 traps on gas lines.	Approx. semi-annually.
		Clean autosampler syringe.	Approx. monthly.
		Change injection port liner and septum.	Approx. every 100 injections.
		Bake system, flush injection port, clip guard column, change analytical column, change carrier hydrocarbon trap.	As needed.
GC – Dissolved methane, ethane, and ethene	Microseeps	Replace septum	As needed.
		Change Dry Rite (carrier gas).	As needed.
		Change activated carbon (H_2^+ unit).	Every 6 months.
		Bake columns at 215°C.	Nightly.
		Maintain proper gas flow rates as per manual.	As needed.
		Replace columns.	As needed.
		Leak checks.	As needed.
HPLC	Laucks Testing Laboratories	Change filter frit in mixer.	As needed (when pressure builds)
		Change column pre-filter.	As needed (2-3 months)
		Rinse water pump with methanol, filter water, sonicate water intake filter frit.	Approximately weekly.
		Change pump seals.	As needed.

TABLE 11-1

**PREVENTIVE MAINTENANCE FOR ANALYTICAL INSTRUMENTS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 3 OF 4**

Instrument	Laboratory	Preventive Maintenance	Maintenance Frequency
ICP/MS	Laucks Testing Laboratories	Clean or change air filters, change pump oil.	Semi-annually.
		Clean torch, replace nebulizer tips, replace pump tubing, replace injector, change cones.	As needed.
		Check mass calibration.	Every 2 weeks.
		Check sensitivity.	Daily.
ICP/AES	Laucks Testing Laboratories	Service Intercooler.	Annually.
		Rinse and clean nebulizer cap and spray chamber.	Monthly or as needed.
		Clean torch, vacuum filters.	Bi-monthly.
		Profile instrument, examine autosampler tubing and replace as needed.	Daily.
		Empty rinse container, fill rinse water reservoir.	As needed.
Mercury Analyzer	Laucks Testing Laboratories	Check and replace pump tubing, check and replace membrane, check and clean windows.	As needed.
Spectro-photometer	Laucks Testing Laboratories	Clean sample compartment and entrance windows.	Semi-annually.
		Check wavelength calibration.	Annually.
Ion Chromatograph	Laucks Testing Laboratories	Replace pump seals.	Annually.
		Lubricate analytical pump motor.	Semi-annually.
		Check chromatography module and all gas lines for leaks.	Every run.
		Clean conductivity detector cell electrodes, check cell calibration.	Monthly.
		Replace bed supports, clean columns, clean AMMS (membrane suppresser), replace autosampler pipette tip.	As needed.

TABLE 11-1

**PREVENTIVE MAINTENANCE FOR ANALYTICAL INSTRUMENTS
NAVAL SURFACE WARFARE CENTER
CRANE, INDIANA
PAGE 4 OF 4**

Instrument	Laboratory	Preventive Maintenance	Maintenance Frequency
Lachat Ion Analyzer	Laucks Testing Laboratories	Lubricate pump. Replace pump tubing. Change cadmium column.	Semi-annually. As needed (~ 1 to 2 months) As needed.
TOC Analyzer	Laucks Testing Laboratories	Change pump tubing. Change other tubing, change furnace tubes, change LiOH tube, change tin trap, adjust optical balance, change septum, change permeation dryer tubing. Change IR filter screen, change gas tubing.	Each run. As needed. Check monthly; replace as needed.
Refrigerators	All	Monitor temperature.	Daily.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Compliance with the quantitative QC objectives for laboratory accuracy and precision as outlined in Tables 3-1 through 3-16 of Section 3.0 will be evaluated during data validation. Compliance with the field data precision specification in Section 3.1.2 will also be evaluated for field duplicates during data validation. The validation process will be used to flag data with quality indicators that fall outside the QC acceptance limits. Compliance with the completeness objectives for field and laboratory data will be computed manually (field data) and electronically via a database subroutine (laboratory data). Sections 12.1, 12.2, and 12.3 present equations to be used for computing precision, accuracy, and completeness values, respectively.

In general, data validation requires that data be evaluated batch-by-batch based on the results of quality indicators for the respective batches. Section 12.4 presents additional data quality considerations that will be evaluated after completion of data validation. These additional considerations are designed to incorporate data quality factors that extend evaluation of the simple quantitative estimators for precision, accuracy, and completeness.

12.1 ACCURACY ASSESSMENT

As discussed in Section 8.2, to assure the accuracy of the analytical procedures, a minimum of 1 of every 20 samples will be spiked with a known amount of the analyte(s) to be evaluated. The spiked sample is then analyzed. The increase in concentration of the analyte observed in the spiked sample, due to the addition of a known quantity of the analyte, compared to the reported value of the analyte in the unspiked sample determines the %R. Control charts are plotted by the laboratory for each commonly analyzed parameter and kept on matrix- and analyte-specific bases. The %R for a spiked sample is calculated by using the following formula:

$$\%R = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100$$

Section 8.2 also discusses the use of surrogate spikes and LCSs as measures of accuracy. The %R for a surrogate spike or LCS is calculated by using the following formula:

$$\%R = \frac{\text{Experimental Concentration}}{\text{Known Amount Added}} \times 100\%$$

12.2 PRECISION ASSESSMENT

As discussed in Section 8.2, laboratory duplicate samples (for inorganic analyses) and MSD samples (for organic analyses) will be prepared and analyzed at a minimum frequency of 1 per every 20 environmental samples. As discussed in Section 3.6, field duplicate samples will also be collected at a minimum frequency of one per 10 environmental samples. The RPD between the sample (or spike) and duplicate (or duplicate spike) is calculated by using the following formula:

$$RPD = \frac{\text{Amount in Sample 1} - \text{Amount in Sample 2}}{0.5\,(\text{Amount in Sample 1} + \text{Amount in Sample 2})} \times 100\%$$

12.3 COMPLETENESS ASSESSMENT

As discussed in detail in Section 3.3, completeness is the ratio of the number of valid sample results to the total number of samples. Following the completion of the analytical testing and data validation, the percent completeness will be calculated using the following equation:

$$\text{Completeness} = \frac{\text{(number of valid measurements)}}{\text{(number of measurements planned)}} \times 100\%$$

12.4 DATA ASSESSMENT

The field and laboratory data collected during the ground water monitoring program for each of the three operating units at NSWC Crane will be used to meet the objectives presented in Table 1-1. The data obtained during each round of sampling and analysis will be both qualitatively and quantitatively assessed on a parameter-specific and unit-specific basis. The results of these assessments will be presented in the reports discussed in Section 1.3 of the Ground Water Monitoring Plan. Examples of issues to be considered in the data assessments are as follows:

- Were all samples obtained using the methodologies and SOPs specified in the FSP?
- Were samples obtained from all sampling locations for all analyses specified in the FSP?

- Were all field analyses performed using the methodologies and SOPs specified in the FSP?
- Were all laboratory analyses performed using the methodologies and SOPs specified in the QAPP?
- Were all field and laboratory data validated as specified in the QAPP?
- Were any data points determined to be unusable (qualified as "R") during the data validation process? If so, are these rejected data points critical in meeting the data quality objectives for the project?
- Were any analytes not expected to be present at a given unit identified?
- Do any analytical results exhibit elevated quantitation limits? If so, what are the causes and what overall impact does this have on the data?
- Did coelution of any chromatographic peaks occur during analysis for explosives? If so, what overall impact does this have on the data?
- Have sufficient data of appropriate quality been generated to support the statistical analysis procedures described in Section 10 of the Ground Water Monitoring Plan and the natural attenuation and karst monitoring described in Sections 7.4 and 7.5 of the Ground Water Monitoring Plan? (Note that Section 10.2 of the Ground Water Monitoring Plan specifies, based upon qualifier codes that may be applied during data validation, how qualified data will be treated during data analysis.)
- Can valid conclusions be drawn for each unit under investigation?

13.0 CORRECTIVE ACTION

Under the TtNUS QA/QC program, it is required that any and all personnel noting conditions adverse to quality report these conditions immediately to the TOM and QAM. These parties, in turn, are charged with performing root-cause analyses and implementing appropriate corrective action in a timely manner. It is ultimately the responsibility of the QAM to document all findings and corrective actions taken and to monitor the effectiveness of the corrective measures performed.

13.1 FIELD CORRECTIVE ACTION

Field nonconformances or conditions adverse to quality must be identified and corrected as quickly as possible so that work integrity or quality of product is not compromised. The need for corrective action may arise based on deviations from project plans and procedures, adverse field conditions, or other unforeseen circumstances. Corrective action needs may become apparent during the performance of daily work tasks or as a consequence of internal or external field audits.

Corrective action may include resampling and may involve amending previously approved field procedures. Minor modifications to field activities, such as the collection of additional samples, will be initiated at the discretion of the FOL, subject to approval by NSWC Crane Environmental Protection Department. Major modifications, such as the elimination of a sampling point, must be approved and documented via a Field Task Modification Request (FTMR). Approval of the corrective action will be obtained by the U.S. Navy (in conjunction with U.S. EPA Region 5 and IDEM). The FOL is responsible for initiating FTMRs; a FTMR will be prepared for all deviations from the project plan documents, as applicable. An example of a FTMR is provided as Figure 13-1. Copies of all FTMRs will be maintained with the onsite project planning documents and will be placed in the final evidence file.

13.2 LABORATORY CORRECTIVE ACTION

In general, laboratory corrective actions are warranted whenever an out-of-control event or potential out-of-control event is noted. The specific corrective action taken depends on the specific analysis and the nature of the event. Generally, the following occurrences alert laboratory personnel that corrective action may be necessary:

FIGURE 13-1
FIELD TASK MODIFICATION REQUEST FORM

Client Identification Project Number FTMR Number

To_____ Location_____ Date_____

Description:

Reason for Change:

Recommended Disposition:

Field Operations Leader (Signature, if applicable) Date

Disposition:

Task Order Manager (Signature, if required) Date

Distribution:
Program Manager
Quality Assurance Officer
Task Order Manager
Field Operations Leader

Others as required_____

- QC data are outside established warning or control limits.
- Method blank analyses yield concentrations of target analytes above acceptable levels.
- Undesirable trends are detected in spike %Rs or in duplicate RPDs.
- There is an unexplained change in compound detection capability.
- Inquiries concerning data quality are received.
- Deficiencies are detected by laboratory QA staff audits or from PE sample test results.

Any corrective action taken above the analyst level that cannot be performed immediately at the instrument will be documented. Corrective actions are typically documented for out-of-control situations on a Corrective Action Form or an Out-of-Control Event Form. Copies of the forms used by Laucks Testing Laboratories, Inc., are included as Appendices 1 and 3 of SOP LTL-1008, which is in Appendix B of this QAPP. Further detail describing the system used by Laucks Testing Laboratories, Inc., to identify, document, and resolve out-of-control events is provided in SOP LTL-1008. Further detail describing the system used by Triangle Laboratories, Inc., to identify, document, and resolve out-of-control events is provided in SOP 2.04. Further detail describing the system used by Microseeps, Inc., to identify, document, and resolve out-of-control events is provided in the Microseeps, Inc., QA Manual. Copies of applicable pages of the Microseeps, Inc., QA Manual are provided in Appendix D of this QAPP.

13.3 CORRECTIVE ACTION DURING DATA VALIDATION AND DATA ASSESSMENT

The need for corrective action may become apparent during data validation, interpretation, or presentation activities. The performance of rework (i.e., resampling or reanalysis), the institution of a change in work procedures, or the provision of additional/refresher training are possible corrective actions relevant to data evaluation activities. The TOM will be responsible for approving the implementation of corrective action.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

QA reports to management will be provided in various formats during the course of the NSWC ground water monitoring program. Data validation letters will be prepared on an SDG-specific basis and will summarize QA issues for the subcontracted laboratory data. In addition, daily reports via telephone summarizing accomplishments and QA/QC issues during the field investigation will be made by the FOL to the TOM. Monthly progress reports will be prepared by the TOM. QA reports will also be prepared by the subcontracted analytical laboratories as QC limits are updated or if significant plan deviations result from unanticipated circumstances. The aforementioned reports are described in the following sections. Several additional reports are required by 40 CFR 264 Subpart F for the Detection and Compliance Monitoring Program. These reports are discussed in Section 1.3 of the approved Ground Water Monitoring Plan.

14.1 CONTENTS OF PROJECT QUALITY ASSURANCE REPORTS

The data validation reports will address all major and minor laboratory noncompliances as well as noted sample matrix effects. In the event that major problems occur with an analytical laboratory (e.g., repeated or extreme holding time exceedances or calibration noncompliances, etc.), the Data Validation Coordinator will notify the TOM, QAM, Technical Program Manager, Deputy Program Manager, and Laboratory Services Coordinator. Such notifications (if necessary) are typically provided via internal memoranda and are placed in the project file. These reports contain a summary of the noncompliance, a synopsis of the impact on individual projects, and recommendations regarding corrective action and compensational adjustments. Corrective actions for major noncompliances are initiated at the program level.

The FOL will provide the TOM with daily reports via telephone during the course of each sampling event. These reports will discuss accomplishments, deviations from the FSP, upcoming activities, and a QA summary. The TOM provides a monthly progress report to the Navy which addresses the project budget, schedule, accomplishments, planned activities, and QA/QC issues and intended corrective actions.

The subcontracted analytical laboratories will provide QA reports to TtNUS whenever QC limits for parameters associated with the NSWC Crane ground water monitoring program are updated or if significant plan deviations result from unanticipated circumstances. Since MDLs/IDLs/RLs, as applicable, will be included in the analytical data packages for NSWC Crane samples, it is not necessary for the

to include updated MDLs/IDLs/RLs in their QA reports unless the updates result in RLs which exceed risk-based target levels.

14.2 FREQUENCY OF QUALITY ASSURANCE REPORTS

The following frequencies will apply to QA reports for the NSWC Crane ground water monitoring program: (1) data validation QA reports - contingent upon SDG delivery data; (2) field progress reports - daily during the course of the each sampling event associated with the ground water monitoring program; (3) monthly progress reports - monthly; (4) laboratory QA reports - as required based on QC limit updates or the occurrence of plan deviations resulting from unanticipated circumstances.

14.3 INDIVIDUALS RECEIVING/REVIEWING QUALITY ASSURANCE REPORTS

Data validation QA reports are provided to the TOM for inclusion in the project files. In the event that major problems are observed for a given laboratory, the Technical Program Manager, Deputy Program Manager, QAM, TOM, and Laboratory Services Coordinator are provided with copies of the QA report. Daily field progress reports via telephone are provided to the TOM. Monthly progress reports are provided to the U.S. Navy. Laboratory QA reports are provided to the TOM; these reports will be forwarded to U.S. EPA Region 5 only if QC updates result in RLs which exceed risk-based target levels or if QC limits for key parameters (e.g., explosives, metals, or other analytes which are associated with the site based on site history) degrade significantly or if any significant plan deviations result from unanticipated circumstances. Copies of any cited written QA reports will be provided to the U.S. EPA Region 5 immediately upon request.

REFERENCES

Aqualab, Inc., 1983. Indiana Army Ammunition Plant Contamination Survey. Nitrocellulose in Water.

Murphy, W.L., May 1994. Final Report, RCRA Facility Investigation, Phase III, Ground Water Release Characterization, SWMU 03/10, Ammunition Burning Ground. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

Murphy, W.L., November 1995. Draft RCRA Facility Investigation, Phase II Ground Water Release Assessment, SWMU 06/09 Demolition Area, and Phase III Release Characterization SWMU 07/09 Old Rifle Range, Naval Warfare Center Crane, Indiana. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

NEESA, (Naval Energy and Environmental Support Activity), May 1983. Initial Assessment Study of Naval Weapons Support Center Crane, Indiana. Port Hueneme, CA.

NFESC, February 1996. Naval Installation Restoration Laboratory Quality Assurance Guide. NFESC Interim Guidance Document.

Rust Environment and Infrastructure, July 1997. Environmental Data Assessment Memorandum for SWMUs #03/10, #06/09, and #07/09, Naval Surface Warfare Center, Crane Division. Minneapolis, MN.

U.S. EPA, March 1983. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. Environmental Monitoring and Support Laboratory Office of Research and Development. Cincinnati, OH.

U.S. EPA, February 1984. Ambient Water Quality Criteria for 2,3,7,8-Tetrachloro-dibenzo-p-dioxin. EPA 440/5-84-007. Office of Water Regulations and Standards. Washington, DC.

U.S. EPA, 1986a. RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD). OSWER-9950.1. Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA, 1986b. Test Methods for Evaluating Solid Waste; Physical/Chemical Methods (SW-846), 3rd edition, up to and including Update III. Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA, March 1989. Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and Dibenzofurans (CDDs and CDFs). Risk Assessment Forum, EPA/625/3-89/016.

U.S. EPA, August 1994. EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, Draft Interim Final. EPA QA/R-5. U.S. EPA Quality Assurance Management Staff, Washington, DC.

U.S. EPA, 1994a. U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA-540/R-94/012. Office of Emergency and Remedial Response, Washington, DC.

U.S. EPA, 1994b. U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA-540/R-94/013. Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA, 1995. Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, ILM04.0. Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA, September 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water. EPA/600/R-98/128. Office of Research and Development, Washington, D.C.

U.S. EPA Region 5, May 1993. Region 5 Model RCRA Quality Assurance Project Plan. Quality Assurance Section, Chicago, IL.

U.S. EPA Region 5, August 1993a. Region 5 Standard Operating Procedure for Validation of CLP Organic Data. Environmental Sciences Division, Central Regional Laboratory, Chicago, IL.

U.S. EPA Region 5, September 1993b. Region 5 Standard Operating Procedure for Validation of CLP Inorganic Data. Environmental Sciences Division, Central Regional Laboratory, Chicago, IL.

U.S. EPA Region 5, September 1995. EDQL, PQL Values for All Media. Environmental Sciences Division, Central Regional Laboratory, Chicago, IL.

U.S. EPA Region 5, December 1995. USEPA Region 5 Waste Management Branch RCRA Data Quality Levels. Environmental Sciences Division, Central Regional Laboratory, Chicago, IL.

U.S. EPA Region 5, April 1998. Region 5 QAPP Policy. Waste, Pesticides, and Toxics Division, Chicago, IL.