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QUALITY ASSURANCE PROJECT PLAN FOR GROUNDWATER MONITORING AT  
SANITARY WASTE LANDFILLNSA CRANE IN  
7/1/2001  
TETRA TECH

**Quality Assurance Project Plan**  
for  
**Ground Water Monitoring**  
at the  
**Sanitary Waste Landfill**

**Naval Surface Warfare Center**  
**Crane Division**  
Crane, Indiana



**Southern Division**  
**Naval Facilities Engineering Command**  
Contract Number N62467-94-D-0888  
Contract Task Order 0048

July 2001

QUALITY ASSURANCE PROJECT PLAN  
FOR  
GROUND WATER MONITORING  
AT THE  
SANITARY WASTE LANDFILL

NAVAL SURFACE WARFARE CENTER, CRANE DIVISION  
CRANE, INDIANA

REVISION 1  
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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:  
Brown & Root Environmental  
661 Andersen Drive  
Foster Plaza 7  
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-94-D-0888  
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 Date 7/12/01  
RALPH R. BASINSKI, Q.E.P.  
TASK ORDER MANAGER  
TETRA TECH NUS, INC.

 Date 7-12-01  
PAUL V. FRANK  
QUALITY ASSURANCE MANAGER  
TETRA TECH NUS, INC.

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## 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 an Operating Permit issued by the Indiana Department of Environmental Management (IDEM) to the Naval Surface Warfare Center (NSWC) Crane Division, located in Crane, Indiana. The permit contains ground water monitoring requirements for the Sanitary Waste Landfill (SWL) at NSWC Crane. Ground water monitoring is to be conducted in accordance with 329 IAC 10 Rule 21, Municipal Solid Waste Landfills; General Ground Water Monitoring Programs and Corrective Action Program Requirements.

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 Field Sampling Plan (TetraTech NUS, 1999). Specific protocols for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses are described herein. All QA/QC procedures are structured in accordance with applicable IDEM requirements, regulations, guidance, and technical standards.

The Naval Facilities Engineering Service Center (NFESC) guidance document entitled "Navy Installation Restoration Laboratory Quality Assurance Guide" (NFESC, February 1996) was used in establishing the QA/QC requirements specified in this QAPP. In addition, the following guidance documents supplied by IDEM were used in the preparation of this QAPP:

- 1995 RCRA Quality Assurance Project Plan (IDEM, 1995)
- Solid Waste Program Analytical Data Deliverable Requirements, A Guidance Document (IDEM, 1998)
- EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations (U.S. EPA, August 1994).
- Correspondence from Sandra Roberts, IDEM Office of Solid and Hazardous Waste Management to Ralph Basinski, TtNUS, dated June 22, 1998 (Roberts, 1998a).
- Correspondence from Sandra Roberts, IDEM Office of Solid and Hazardous Waste Management to Ralph Basinski, TtNUS, dated June 23, 1998 (Roberts, 1998b).

## 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 Field Sampling Plan (FSP) (TetraTech NUS, 1999). Current project status and QAPP preparation guidelines are discussed. This QAPP has been prepared by TetraTech NUS (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) 048. An FSP has also been prepared for the project by TtNUS (1999). Pertinent QAPP-related information from the FSP prepared for the facility is incorporated into the QAPP through specific reference.

### 1.1.1 Overall Project Objectives

The overall objectives of the ground water monitoring programs for the SWL at NSWC are outlined in Table 1-1, under the column entitled "Type of Program Sampling/Objective." In keeping with these overall objectives, the primary objective of the QAPP for the SWL is to establish an analytical program for the SWL that will be capable of measuring constituents at concentrations which are protective of human health (i.e., Safe Drinking Water Act Maximum Contaminant Levels [MCLs], alternative risk-based criteria). The data collected must be of sufficient quality to meet the primary objective of the QAPP.

Table 1-1 identifies the evaluations to be performed to fulfill the overall objectives of the project. Background water quality will be established. Statistical comparisons between upgradient and downgradient well concentrations will be performed in accordance with the statistical evaluation procedures described in 329 IAC 10-21-6.

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 ground water monitoring program at the NSWC Crane SWL will be conducted in a phased approach. Initially, detection monitoring will be conducted to identify statistically significant increases from background. Background water quality will be established. Downgradient water quality will also be established. The background and downgradient water quality will be evaluated to determine the appropriate statistical procedures as per 329 IAC 10-21-6. Downgradient ground water concentrations will be statistically compared to upgradient concentrations. If there are no statistically significant exceedences in downgradient wells, detection monitoring will continue. If a statistically significant

TABLE 1-1

SUMMARY OF GROUNDWATER MONITORING REQUIREMENTS  
 NAVAL SURFACE WARFARE CENTER  
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Type of 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
Type: Detection Monitoring  Objectives: <ul style="list-style-type: none"> <li>• Monitor upgradient ground water to determine background concentrations.</li> <li>• Monitor downgradient ground water to determine if statistically significant increases above background concentrations have occurred.</li> </ul>	Field	<ul style="list-style-type: none"> <li>• Dissolved oxygen</li> <li>• PH</li> <li>• Specific conductivity</li> <li>• Temperature</li> <li>• Turbidity</li> <li>• Oxidation-reduction potential</li> </ul>	Determine if the well water is equivalent to formation water (i.e., stability).	NA	Semiannually: <ul style="list-style-type: none"> <li>• Dissolved oxygen</li> <li>• PH</li> <li>• Specific conductivity</li> <li>• Temperature</li> <li>• Turbidity</li> <li>• Oxidation-reduction potential</li> <li>• Metals<sup>(1)</sup> (total and dissolved)</li> <li>• VOCs<sup>(1)</sup></li> <li>• Chloride</li> <li>• TDS/Total Solids</li> <li>• Sulfate</li> <li>• Alkalinity</li> <li>• Carbonate</li> <li>• Ammonia</li> <li>• Bicarbonate</li> <li>• Water level measurements</li> </ul>	Upgradient: <ul style="list-style-type: none"> <li>• MW201, MW1A, MW1B</li> </ul> Downgradient: <ul style="list-style-type: none"> <li>• MW203, NW2A, MW3A, MW4A, MW5A, MW6A, MW7A, MW3B, MW4B, MW5B, MW6B, WES-14-1-93, WES-14-2-93, WES-14-3-93, WES-14-4-93, WES-14-5-93, WES-14-6-93, WES-14-7-93</li> </ul>	Monitor quality of background water in each aquifer that has not been affected by operations of the unit.  Monitor quality of water passing under the sanitary waste landfill.	Determine if statistically significant evidence of contamination exists by the comparison of downgradient concentrations to upgradient concentrations in each aquifer.
		<ul style="list-style-type: none"> <li>• Slug tests</li> <li>• Water level measurements</li> </ul>	Determine GW flow rate, direction, and aquifer characteristics.	0.01 feet.				
	Laboratory	<ul style="list-style-type: none"> <li>• Metals<sup>(1)</sup> (dissolved)</li> <li>• Ammonia</li> <li>• VOCs</li> </ul>	Monitor constituents that indicate the presence of GW constituents attributable to operations. Subject to statistical evaluation per 329 IAC 10-21-6.	Reporting limit low enough to meet criteria listed in Table 1-3. <sup>(3)</sup>				
	<ul style="list-style-type: none"> <li>• Chloride</li> <li>• TDS/Total Solids</li> <li>• Alkalinity</li> <li>• Carbonate</li> <li>• Bicarbonate</li> <li>• Sulfate</li> </ul>	Monitor constituents that indicate the presence of constituents attributable to operations. Not subject to statistical evaluation per 329 IAC 10-21-6.	Reporting limit low enough to meet criteria listed in Table 1-2. <sup>(2)</sup>					

TABLE 1-1  
 SUMMARY OF GROUNDWATER MONITORING REQUIREMENTS  
 NAVAL SURFACE WARFARE CENTER  
 CRANE, INDIANA  
 PAGE 2 OF 2

Type of 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 <sup>(2)</sup>
Type: Assessment Monitoring  Objectives: • Monitor GW for compliance with GW protection standards established under 329 IAC 10-21-11.	Field	<ul style="list-style-type: none"> <li>Dissolved oxygen</li> <li>PH</li> <li>Specific conductivity</li> <li>Temperature</li> <li>Turbidity</li> <li>Oxidation-reduction potential</li> </ul>	Determine if the well water is equivalent to formation water (i.e., stability).	NA	Within 90 days of determination that statistically significant increases have occurred in one or more downgradient wells. Further background and downgradient well sampling and analysis are based on results of initial assessment monitoring sampling.	Upgradient wells with statistically significant elevated concentrations and all their adjacent wells.	Monitor quality of background water in each aquifer that has not been affected by operations of the unit.	Compare concentrations of contaminants of concern to ground water protection standards.
		<ul style="list-style-type: none"> <li>Water level measurements</li> </ul>	Determine GW flow direction.	0.01 feet			Monitor contaminant distribution and compliance with ground water protection standard operations of the unit.	
	Laboratory	<ul style="list-style-type: none"> <li>Metals<sup>(1)</sup> (total and dissolved)</li> <li>Cyanide</li> <li>VOCs<sup>(1)</sup></li> <li>SVOCs<sup>(1)</sup></li> <li>Organochlorine pesticides/PCBs<sup>(1)</sup></li> <li>Herbicides<sup>(1)</sup></li> <li>Cyanide</li> <li>Nitrate</li> <li>Sulfide</li> <li>Fluoride</li> </ul>	Monitor constituents that indicate the presence of GW constituents attributable to operations.	Reporting limit low enough to meet GW criteria listed in Table 1-3. <sup>(2)</sup>				

GW Ground water  
 IDEM Indiana Department of Environmental Management

MCLs Maximum Contaminant Levels  
 NA Not applicable  
 PCBs Polychlorinated biphenyls

PRGs Preliminary Remediation Goals  
 SVOCs Semivolatile organic compounds

VOCs Volatile organic compounds

1 See Tables 1-2 and 1-3 for the list of specific chemicals and analytical methods.  
 2 Human health-based criteria consist of Federal MCLs and U.S. EPA Region IX PRGs for tap water.

increase in concentration is found for any constituent listed in 329 IAC 10 Rule 21 Table 1A, assessment monitoring will be conducted for the well(s) in which the statistically significant increase was found and adjacent wells.

Table 1-1 provides a summary of the ground water monitoring requirements, as described in the NSWC Crane SWL operating permit and 329 IAC 10 Rule 21. Ground 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 requirements in 329 IAC 10 Rule 21. The monitoring wells were identified in the permit.

The results of the sampling, direct comparisons, and statistical evaluations conducted for the detection monitoring will be used to determine subsequent actions, such as assessment monitoring and corrective action.

### **1.1.3 QAPP Preparation Guidelines**

This QAPP has been prepared in accordance with the guidance documents identified above. Additional guidance regarding the generation of the QAPP was obtained during various project scoping telephone conferences with IDEM.

## **1.2 SITE/FACILITY DESCRIPTION**

A brief description of NSWC Crane with respect to the SWL, its geological setting, and associated features is presented in this section. Additional details can be found in Section 2.0 of the FSP (TINUS, 1999); specific sub-sections and figures of the 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. 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 2-1 of the FSP shows the location of the SWL. The SWL lies in an upland area in the west-central section of NSWC Crane, adjacent to its western boundary.

### **1.2.2 Facility Size and Borders**

The SWL consists of about 65 acres. Figure 2-1 of the FSP shows the location of the SWL, including the proximity of the SWL to the borders of NSWC Crane.

### **1.2.3 Natural and Manmade Features**

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

### **1.2.4 Topography**

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

### **1.2.5 Local Hydrology and Hydrogeology**

See Section 2.4 of the FSP for information on local hydrogeology and Section 2.5 of the FSP for information on local geology and stratigraphy for the SWL.

## **1.3 FACILITY HISTORY**

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

### **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.

### **Sanitary Waste Landfill**

Operations began at the active, 65-acre landfill in 1972. The landfill currently receives trash and garbage from production operations and residential and food preparation areas. Special approval was granted by the Indiana State Bureau of Health (ISBH) in 1981-1982 to bury neutralized lithium batteries in the SWL.

Ground water monitoring is required under NSWC Crane's Operating Permit (Permit Number 51-2) issued by the ISBH.

### **1.3.2 Past Data Collection Activities**

Historical data were not available for evaluation in this QAPP.

## **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 IDEM operating permit, are presented in Section 1.4.3.

### **1.4.1 Specific Objectives and Associated Tasks**

Indiana regulations on ground water monitoring requirements (329 IAC 10 Rule 21) provide for two levels of monitoring for landfills. Detection monitoring is used to determine if any contamination is resulting from landfill operations. Assessment monitoring, used when detection monitoring indicates that landfill operations may be impacting ground water quality, is performed to examine the extent of such contamination. The specific objectives of data collection for ground water monitoring 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 health risks. These analyses require full documentation of the chosen U.S. EPA SW-846 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 related to detection monitoring is included in Table 1-2. Field measurements and laboratory data will be obtained 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

TABLE 1-2  
 ANALYTICAL METHODS AND LIMITS OF DETECTION  
 DETECTION MONITORING  
 NAVAL SURFACE WARFARE CENTER  
 CRANE, INDIANA  
 PAGE 1 OF 2

Chemical	Table 1A Compound Number <sup>(1)</sup>	Laboratory MDL/IDL <sup>(2)</sup> (ug/L)	Laboratory RL <sup>(2)</sup> (ug/L)	Target Level <sup>(3)</sup> (ug/L)
<b>METALS (SW-846 METHOD 6010B ICP/AES, UNLESS OTHERWISE NOTED)</b>				
Cadmium (Dissolved)	3	1.5	5	5
Chromium (Dissolved)	9	9	50	100
Copper (Dissolved)	10	2.3	25	1300
Lithium (Dissolved) (SW-846 Method 6020 ICP/MS)	NA	0.058	10	730
Zinc (Dissolved)	38	2.8	20	5000
Calcium (Dissolved)	9 - Table 1B	112	1000	NA
Iron (Dissolved)	11 - Table 1B	16	100	11000
Magnesium (Dissolved)	12 - Table 1B	33	1000	NA
Manganese (Dissolved)	13 - Table 1B	1.5	15	1700
Potassium (Dissolved)	14 - Table 1B	147	1000	NA
Sodium (Dissolved)	26	28	1000	NA
<b>VOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8260B WITH 25 ML PURGE)</b>				
1,1,1-Trichloroethane	32	0.17	1	200
1,1,1,2-Tetrachloroethane	28	0.13	1	4.3
1,1,2,2-Tetrachloroethane	29	0.10	0.5	0.55
1,1,2-Trichloroethane	33	0.14	1	5
1,1-Dichloroethane	13	0.17	1	810
1,1-Dichloroethene	15	0.12	1	7
1,2-Dichlorobenzene	11	0.12	1	600
1,2-Dichloroethane	14	0.14	1	5
1,2-Dichloropropane	18	0.14	1	1.6
1,4-Dichlorobenzene	12	0.16	1	75
Benzene	2	0.013	1	5
Bromomethane	22	0.59	1	8.7
Carbon tetrachloride	4	0.17	1	5
Chlorobenzene	6	0.18	1	100
Chloroethane	7	0.21	1	NA
Chloroform	8	0.14	1	100
Chloromethane	23	0.17	1	15
cis-1,2-Dichloroethene	16	0.10	1	70
cis-1,3-Dichloropropene	19	0.16	1	NA
Ethylbenzene	21	0.076	1	700
Methylene chloride	24	0.19	1	5
Styrene	25	0.10	1	100
Tetrachloroethene	30	0.16	1	5
Toluene	31	0.04	1	1000
trans-1,2-Dichloroethene	17	0.10	1	100
trans-1,3-Dichloropropene	20	0.10	1	NA
Trichloroethene	34	0.12	1	5
Trichlorofluoromethane	35	0.14	1	1300
Vinyl chloride	36	0.20	1	2
Total Xylenes	37	0.18	1	10000
<b>MISCELLANEOUS PARAMETERS</b>				
Ammonia (EPA Method 350.1)	1	5.6	10	NA
Alkalinity (SM 2320B)	7 - Table 1B	NA	2000	NA
Bicarbonate (SM 2320B)	8 - Table 1B	NA	2000	NA
Carbonate (SM 2320B)	10 - Table 1B	NA	2000	NA

TABLE 1-2

**ANALYTICAL METHODS AND LIMITS OF DETECTION  
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Chemical	Table 1A Compound Number <sup>(1)</sup>	Laboratory MDL/IDL <sup>(2)</sup> (ug/L)	Laboratory RL <sup>(2)</sup> (ug/L)	Target Level <sup>(3)</sup> (ug/L)
Chloride (SW-846 Method 9056)	5	80	1000	NA
Sulfate (SW-846 Method 9056)	27	74.2	1000	NA
Total Dissolved Solids (EPA Method 160.1)	6 - Table 1B	NA	2000	NA
Total Solids (EPA Method 160.3)	5 -Table 1B	NA	2000	NA

ug/L micrograms per liter

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

NA Not Available

1 As presented in 329 FAC 10-21-15.

2 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. These values may change throughout the course of the ground water monitoring program as laboratory MDLs and IDLs are updated.

3 Developed using Federal MCLs (Primary or Secondary), where available. If no MCLs are available, Region IX PRGs for carcinogens at a level of 1E-5 risk, or noncarcinogens at a hazard level of 1.0 were used.

the SWL are provided in Tables 4-1 through 4-7 of the FSP (TtNUS, 1999). Statistical evaluations of the laboratory data will be performed to determine whether downgradient well concentrations are statistically greater than upgradient well concentrations.

In the event that statistical evaluation of the data from detection monitoring indicates the possibility of contamination of the ground water by the SWL operations, then assessment monitoring will be performed, as specified in 329 IAC 10 Rule 21. The list of target parameters related to assessment monitoring is included in Table 1-3. Laboratory data will be obtained to meet the project objectives outlined in Table 1-1.

### **Field Parameters**

Measurements of dissolved oxygen, pH, specific conductivity, temperature, turbidity, and water level will be performed during each detection monitoring sampling event at the SWL. In addition, measurements of oxidation-reduction potential (ORP/Eh) will be performed. Flow direction will be determined at each unit annually.

### **Laboratory Parameters**

The list of laboratory parameters (and likely chemicals of concern) for each unit was developed based on the ground water monitoring requirements listed in 329 IAC 10-21-15 and 10-21-16. The general list of laboratory parameters to be analyzed is provided in Table 1-1. Further details regarding the specific sampling and analytical program are provided in Tables 4-2 and 4-3 of the FSP (TtNUS, 1999). During detection monitoring (Table 1-2), the analytical program will consist of selected volatile organic parameters, selected dissolved metals (including lithium), ammonia, alkalinity, bicarbonate, carbonate, chloride, sulfate, total solids, and total dissolved solids. For assessment monitoring (Table 1-3), the analyses include a full suite of organic parameters (volatiles, semivolatiles, organochlorine pesticides, PCBs, and herbicides), total and dissolved metals, and several miscellaneous parameters (cyanide, fluoride, nitrate, and sulfide).

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 Tables 1-2 and 1-3. Further information, including references, regarding analytical methods is provided in Section 7.0.

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION  
ASSESSMENT MONITORING  
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NSWC, Crane  
QAPP  
Revision: 2  
Date: August 1999  
Section: 1  
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Chemical	Table 2 Compound Number <sup>(1)</sup>	Laboratory MDL/IDL <sup>(2)</sup> (ug/L)	Laboratory RL <sup>(2)</sup> (ug/L)	Target Level <sup>(3)</sup> (ug/L)
<b>METALS (SW-846 METHOD 6010B ICP, UNLESS OTHERWISE NOTED)</b>				
Antimony (Total and Dissolved) (SW-846 Method 6020)	13,14	1.0	1.0	6
Arsenic (Total and Dissolved) (SW-846 Method 6020)	15,16	1.0	1.0	50
Barium (Total and Dissolved)	17,18	0.8	200	2000
Beryllium (Total and Dissolved)	26,27	0.5	5*	4
Cadmium (Total and Dissolved)	41,42	1.5	5	5
Chromium (total) (Total and Dissolved)	56,57	9	50	100
Cobalt (Total and Dissolved)	59,60	5.1	50	2200
Copper (Total and Dissolved)	61,62	2.3	25	1300
Lead (Total and Dissolved) (SW-846 Method 6020)	141,142	0.5	1.0	15
Lithium (Total and Dissolved) (SW-846 Method 6020)	143,144	0.058	10	730
Mercury (Total and Dissolved) (SW-846 Method 7470A)	145,146	0.06	0.2	2
Nickel (Total and Dissolved)	166,167	5.1	40	100
Selenium (Total and Dissolved) (SW-846 Method 6020)	198,199	1.0	1.0	50
Silver (Total and Dissolved)	200,201	4.7	10	100
Thallium (Total and Dissolved) (SW-846 Method 6020)	211,212	0.5	1.0	2
Tin (Total and Dissolved) (SW-846 Method 6020)	213,214	0.1	10	22,000
Vanadium (Total and Dissolved)	228,229	3.3	50	260
Zinc (Total and Dissolved)	233,234	2.8	20	5000
<b>VOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8260B WITH 25 ML PURGE)</b>				
1,1,1-Trichloroethane	219	0.17	1	200
1,1,1,2-Tetrachloroethane	207	0.13	1	4.3
1,1,2,2-Tetrachloroethane	208	0.10	0.5	0.55
1,1,2-Trichloroethane	220	0.14	1	5
1,2,3-Trichloropropane	225	0.54	1 <sup>(4)*</sup>	0.016
1,1-Dichloroethane	84	0.17	1	810
1,1-Dichloroethene	86	0.12	1	7
1,1-Dichloropropene	94	0.15	1	NA
1,2-Dibromo-3-chloropropane	75	0.30	1*	0.2
1,2-Dibromoethane	76	0.13	0.5*	0.0076
1,2-Dichloroethane	85	0.14	1	5
1,2-Dichloropropane	91	0.14	1	1.6
1,3-Dichloropropane	92	0.15	1	NA
2,2-Dichloropropane	93	0.18	1	NA
2-Butanone	153	0.86	5	1900
2-Chloro-1,3-butadiene (chloroprene)	55	0.40	1	14
2-Hexanone	134	0.92	5	NA
4-Methyl-2-pentanone	159	0.52	5	160
Acetone	3	1.8	5	610
Acrolein	7	4.6	10*	0.042
Acrylonitrile	8	1.3	3	37
Allyl chloride (3-chloro-1-propene)	10	0.22	1	1800
Benzene	19	0.013	1	5
Bromochloromethane	36	0.18	1	NA
Bromodichloromethane	37	0.13	1	100
Bromoform	38	0.18	1	100
Bromomethane	150	0.59	1	8.7
Carbon disulfide	43	0.13	1	1000
Carbon tetrachloride	44	0.17	1	5
Chlorobenzene	47	0.18	1	100
Chloroethane	50	0.21	1	NA
Chloroform	51	0.14	1	100
Chloromethane	151	0.17	1	15
cis-1,2-Dichloroethene	87	0.10	1	70
cis-1,3-Dichloropropene	95	0.16	0.5	0.81

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION  
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Chemical	Table 2 Compound Number <sup>(1)</sup>	Laboratory MDL/IDL <sup>(2)</sup> (ug/L)	Laboratory RL <sup>(2)</sup> (ug/L)	Target Level <sup>(3)</sup> (ug/L)
Dibromochloromethane	74	0.10	1	100
Dibromomethane	160	0.19	0.5*	0.0076
Dichlorodifluoromethane	83	0.18	1	390
Ethylbenzene	120	0.076	1	700
Ethyl methacrylate	121	0.31	1	550
Methacrylonitrile	147	0.15	1	1
Methylene chloride	161	0.19	1	5
Methyl iodide	154	0.28	1	NA
Methyl methacrylate	155	0.29	1	1400
Styrene	203	0.10	1	100
Tetrachloroethene	209	0.16	1	5
Toluene	215	0.04	1	1000
trans-1,2-Dichloroethene	88	0.10	1	100
trans-1,3-Dichloropropene	96	0.10	1	NA
trans-1,4-Dichloro-2-butene	82	0.34	10*	0.012
Trichloroethene	221	0.12	1	5
Trichlorofluoromethane	222	0.14	1	1300
Vinyl acetate	230	0.21	1	410
Vinyl chloride	231	0.20	1	2
Total Xylenes	232	0.18	1	10000
<b>VOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8015B WITH 10 ML PURGE)</b>				
Acetonitrile (SW-846 Method 8015B)	4	7.6	40	71
Isobutyl alcohol (SW-846 Method 8015B)	136	3.4	40	1800
Propionitrile (SW-846 Method 8015B)	195	2.9	40	NA
<b>SEMIVOLATILE ORGANIC COMPOUNDS (SW-846 METHOD 8270C)</b>				
1,2,4,5-Tetrachlorobenzene	206	2.7	10	11
1,2,4-Trichlorobenzene	218	0.43	5	70
1,2-Dichlorobenzene	78	0.74	5	600
1,3,5-Trinitrobenzene	227	4.2	10	1100
1,3-Dichlorobenzene	79	0.68	5	17
1,3-Dinitrobenzene	106	3	10*	3.7
1,4-Dichlorobenzene	80	0.65	5	75
1,4-Naphthoquinone	163	3.7	10	NA
1,4-Phenylenediamine	191	25	100	6900
1-Naphthylamine	164	18	36	NA
2,3,4,6-Tetrachlorophenol	210	12	25	1100
2,4,5-Trichlorophenol	223	2.1	5	3700
2,4,6-Trichlorophenol	224	0.89	5	61
2,4-Dichlorophenol	89	1.49	5	110
2,4-Dimethylphenol	104	1.44	5	730
2,4-Dinitrophenol	108	0.12	10	73
2,4-Dinitrotoluene	109	0.59	5	73
2,6-Dichlorophenol	90	5.4	10	NA
2,6-Dinitrotoluene	110	0.39	5	37
2-Acetylaminofluorene	6	4.2	10	NA
2-Chloronaphthalene	52	0.60	5	490
2-Chlorophenol	53	1.4	5	38
2-Methylnaphthalene	157	0.83	5	NA
2-Methylphenol	64	0.36	5	1800
2-Naphthylamine	165	5.2	10	NA
2-Nitroaniline	169	0.60	5	2.2
2-Nitrophenol	173	1.1	5	NA
3,3'-Dichlorobenzidine	81	0.59	10*	1.5
3,3'-Dimethylbenzidine	103	25	50*	0.073
3-Methylcholanthrene	152	3.9	10	NA
3- and 4-Methylphenol <sup>(5)</sup>	63	0.70	10	1800

TABLE 1-3  
 ANALYTICAL METHODS AND LIMITS OF DETECTION  
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Chemical	Table 2 Compound Number <sup>(1)</sup>	Laboratory MDL/IDL <sup>(2)</sup> (ug/L)	Laboratory RL <sup>(2)</sup> (ug/L)	Target Level <sup>(3)</sup> (ug/L)
3-Nitroaniline	170	0.54	5	NA
4,6-Dinitro-2-methylphenol	107	0.31	10	NA
4-Aminobiphenyl	11	3.4	10	NA
4-Bromophenyl phenyl ether	39	0.31	5	NA
4-Chloro-3-methylphenol	49	0.66	5	NA
4-Chloroaniline	46	0.60	5	150
4-Chlorophenyl phenyl ether	54	0.24	5	NA
4-Methylphenol <sup>(5)</sup>	65			180
4-Nitroaniline	171	0.87	10	NA
4-Nitrophenol	174	0.24	10	2300
5-Nitro-o-toluidine	183	8.0	16	NA
7,12-Dimethylbenz(a)acene	102	7.0	20	NA
Acenaphthene	2	0.71	5	370
Acenaphthylene	1	0.61	5	NA
Acenaphthone	5	3.3	20*	0.042
Anthracene	12	0.17	5	1800
Benzo(a)anthracene	20	0.3	5*	0.92
Benzo(a)pyrene	24	0.54	5*	0.2
Benzo(b)fluoranthene	21	0.58	5*	0.92
Benzo(g,h,i)perylene	23	0.41	5	NA
Benzo(k)fluoranthene	22	0.54	5	9.2
Benzyl alcohol	25	0.62	5	11000
Bis(2-chloroethoxy)methane	32	1.0	5	NA
Bis(2-chloroethyl)ether	33	0.58	1 <sup>(4)</sup> *	0.098
Bis(2-chloroisopropyl)ether	34	0.29	3*	2.7
Bis(2-ethylhexyl)phthalate	35	0.46	5	6
Butyl benzyl phthalate	40	0.58	5	7300
Chlorobenzilate	48	3.4	5 <sup>(4)</sup> *	2.5
Chrysene	58	0.25	5	92
Diallate	71	3.5	10	11
Dibenzo(a,h)anthracene	72	0.26	5*	0.092
Dibenzofuran	73	0.29	5	24
Diethyl phthalate	98	0.55	10	29000
Dimethoate	100	5.4	10 <sup>(4)</sup> *	7.3
Dimethyl phthalate	105	0.28	5	365000
Di-n-butyl phthalate	77	0.28	5	3700
Di-n-octyl phthalate	112	0.67	5	730
Diphenylamine	113	3.6	10	910
Disulfoton	114	8.54	16 <sup>(4)</sup> *	1.5
Ethyl methane sulfonate	122	4.80	10	NA
Famphur	123	2.60	10	NA
Fluoranthene	124	0.37	5	1500
Fluorene	125	0.49	5	240
Hexachlorobenzene	129	0.30	2*	1
Hexachlorobutadiene	130	0.63	5	8.6
Hexachlorocyclopentadiene	131	0.05	5	50
Hexachloroethane	132	0.71	5	48
Hexachloropropene	133	4.0	10	NA
Indeno(1,2,3-cd)pyrene	135	0.23	5*	0.92
Isodrin	137	3.4	10	NA
Isophorone	138	0.48	5	710
Isosafrole	139	2.9	10	NA
Kepone	140	6.2	25*	0.037
Methapyriene	148	17	40	NA
Methyl methane sulfonate	156	4.1	10	NA

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION  
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Chemical	Table 2 Compound Number <sup>(1)</sup>	Laboratory MDL/IDL <sup>(2)</sup> (ug/L)	Laboratory RL <sup>(2)</sup> (ug/L)	Target Level <sup>(3)</sup> (ug/L)
Methyl parathion	158	4.98	10*	9.1
Naphthalene	162	0.87	5	6.2
Nitrobenzene	172	0.7	5*	3.4
n-Nitrosodiethylamine	176	3.3	10*	0.0045
n-Nitrosodimethylamine	177	0.44	10*	0.013
n-Nitrosodi-n-butylamine	175	4.7	10*	0.02
n-Nitrosodi-n-propylamine	179	0.39	2*	0.096
n-Nitrosodiphenylamine	178	2.2	10	140
n-Nitrosomethylethylamine	180	3.6	10*	0.031
n-Nitrosopiperidine	181	3.6	10	NA
n-Nitrosopyrrolidine	182	3.0	10*	0.32
O,O,O-Triethyl phosphorothioate	226	4.6	10	NA
o-Toluidine	216	5.2	10	NA
p-(Dimethylamino)azobenzene	101	3.7	10	NA
Parathion	184	5.23	10	220
Pentachlorobenzene	185	4.7	10	29
Pentachloronitrobenzene	186	3.8	10*	2.6
Pentachlorophenol	187	0.97	10*	1
Phenacetin	188	1.6	10	NA
Phenanthrene	189	0.16	5	NA
Phenol	190	1.5	5	22000
Phorate	192	5.06	25*	7.3
Pronamide	194	3.3	10	2700
Pyrene	196	0.23	5	180
Safrole	197	2.7	10	NA
Thionazin	99	4.0	10	NA
<b>ORGANOCHLORINE PESTICIDES and PCBs (SW-846 METHOD 8081)</b>				
Aldrin	9	0.0028	0.01	0.04
Alpha-BHC	28	0.0031	0.05	0.11
Beta-BHC	29	0.0024	0.05	0.37
Chlordane	45	0.0098	0.5	2
4,4'-DDD	68	0.0035	0.1	2.8
4,4'-DDE	69	0.0029	0.1	2
4,4'-DDT	70	0.0048	0.1	2
Delta-BHC	30	0.0020	0.05	NA
Dieldrin	97	0.0060	0.02	0.042
Endosulfan I	115	0.0033	0.05	220
Endosulfan II	116	0.0052	0.1	220
Endosulfan sulfate	117	0.0061	0.1	NA
Endrin	118	0.0084	0.1	2
Endrin aldehyde	119	0.0069	0.1	NA
Gamma-BHC (Lindane)	31	0.0037	0.05	0.2
Heptachlor	127	0.0030	0.05	0.15
Heptachlor epoxide	128	0.0023	0.05	0.074
Methoxychlor	149	0.0226	0.5	40
Toxaphene	217	1.1	3.0	3
Aroclor-1016	193	0.094	0.5	0.5
Aroclor-1221	193	0.084	0.5	0.5
Aroclor-1232	193	0.23	0.5	0.5
Aroclor-1242	193	0.37	0.5 <sup>(4)</sup>	0.5
Aroclor-1248	193	0.11	0.5	0.5
Aroclor-1254	193	0.11	0.5	0.5
Aroclor-1260	193	0.095	0.5	0.5
<b>HERBICIDES (SW-846 METHOD 8151A)</b>				
2,4-D	67	0.021	0.08	70

TABLE 1-3

ANALYTICAL METHODS AND LIMITS OF DETECTION  
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Chemical	Table 2 Compound Number <sup>(1)</sup>	Laboratory MDL/IDL <sup>(2)</sup> (ug/L)	Laboratory RL <sup>(2)</sup> (ug/L)	Target Level <sup>(3)</sup> (ug/L)
2,4,5-T	205	0.011	0.04	370
2,4,5-TP (Silvex)	202	0.003	0.04	50
Dinoseb	111	0.035	0.08	7
<b>MISCELLANEOUS PARAMETERS</b>				
Cyanide (SW-846 Method 9012A)	66	2.4	10	200
Nitrate (SW-846 Method 9056)	168	15.3	200	10000
Sulfide (SW-846 Method 9034)	204	800	1000	NA
Fluoride (SW-846 Method 9056)	126	17	200	4000

ug/L micrograms per liter

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

NA Not available.

1 As presented in 329 CFR 19.21-16.

2 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. These values may change throughout the course of the ground water monitoring program as laboratory MDLs and IDLs are updated.

3 Developed using Federal MCLs (Primary or Secondary), where available. If no MCLs are available, Region IX PRGs for carcinogens at a level of 1E-5 risk, or noncarcinogens at a hazard level of 1.0 were used.

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.

Also included in Tables 1-2 and 1-3 are the project-specific 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 target levels presented in Tables 1-2 and 1-3 are the Federal Maximum Contaminant Levels (MCLs), where available. For those compounds with no Federal MCL, the target levels are based on Preliminary Remedial Goals (PRGs) from U.S. EPA Region IX are listed, where available. The PRGs are risk-based concentrations calculated assuming tap water ingestion and are established at a cancer risk level of 1-in-100,000 (1E-5) for carcinogens, or a hazard level of unity (1.0) for noncarcinogens. In some cases, the target level reflects the lowest limit of detection available using common laboratory analytical methods. A tabular presentation of the human health target levels used as a basis for determining the target levels is provided in Appendix A, Table A-1.

TtNUS worked closely with the analytical laboratory 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 target levels. In certain cases, RLs for some analytes still do not meet the associated target levels; the laboratory RLs of these analytes are marked with asterisks (\*) on Tables 1-2 and 1-3.

The RLs for all parameters listed in Table 1-2 for detection monitoring are less than the associated target levels.

For the assessment monitoring parameters, the RLs for one metal (beryllium), six volatile organic compounds (VOCs) (1,2,3-trichloropropane; 1,2-dibromo-3-chloropropane; 1,2-dibromoethane; acrolein; dibromomethane; and trans-1,4-dichloro-2-butene) and 27 semivolatile organic compounds (SVOCs) (1,3-dinitrobenzene; 3,3'-dichlorobenzidine; 3,3'-dimethylbenzidine; acetophenone; benzo(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; bis(2-chloroethyl)ether; bis(2-chloroisopropyl)ether; chlorobenzilate; dibenzo(a,h)anthracene; dimethoate; disulfoton; hexachlorobenzene; indeno(1,2,3-cd)pyrene; kepone; methyl parathion; nitrobenzene; n-nitrosodiethylamine; n-nitrosodimethylamine; n-nitrosodi-n-butylamine; n-nitrosodi-n-propylamine; n-nitrosomethylethylamine; n-nitrosopyrrolidine; pentachloronitrobenzene; pentachlorophenol; and phorate) exceed the associated target levels. Five of the target levels which are exceeded are associated with Federal MCLs (beryllium; 1,2-dibromo-3-chloropropane; benzo(a)pyrene; hexachlorobenzene; and pentachlorophenol). The rest of the exceedences mentioned above correspond to Region IX PRGs.

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.

It should be 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 NSWC Crane based on site history. Therefore, it was determined 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 3-7 and 3-8 in Section 3 of this QAPP).

Based on the length of time that the ground water monitoring program (lifetime of the unit) will be in place, 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 IDEM only if the updates result in RLs which exceed the target levels. Updated QC limits will be reported to IDEM only if the limits for key analytes (e.g., 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.

#### **1.4.3 Data Quality Objectives**

Ground water at the SWL is being monitored for compliance with ground water monitoring, as described in 329 IAC 10 Rule 21.

329 IAC 10 Rule 21 specifies target levels or concentration limits for constituents for which ground water and surface water monitoring is to be conducted. These target levels are protective of human health. The overall objective of ground water and surface water monitoring at the SWL is to meet requirements of

the operating permit, including the target levels for constituents. This objective is attained by the following activities:

- Development of a sampling and analysis plan that provides data with a high degree of representativeness of actual ground water conditions at the SWL.
- Selection of methods of analysis that are sensitive enough to meet the project-specific target levels.
- Collection of representative ground water samples through standardized and documented sampling procedures.
- Comparison of resulting analytical data to the project-specific target levels.

The specific DQOs for the project are, as follows:

- The objective of field sampling and laboratory analysis is to obtain 100 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 comply with the QC limits established for this project.
- The laboratory-derived MDLs, IDLs, and RLs for the chosen analytical methods will meet or exceed the project-specific 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 Section 4 of the FSP SWL (TtNUS, 1999). Rationale for the selection of the type of monitoring program (detection and assessment) is provided by 329 IAC 10 Rule 21.

### **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 is provided in Tables 4-1 through 4-7 of the FSP (TtNUS, 1999).

### **1.5.2 Site Maps of Sampling Locations**

Figure 3-1 of the FSP (TtNUS, 1999) shows the locations of the ground water monitoring wells to be sampled at the SWL.

### **1.5.3 Rationale of Selected Sampling Locations**

All existing monitoring wells specified in the permit for the SWL will be included in the sampling program. 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 FSP for the SWL.

## 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 FSP (TtNUS, 1999). 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 groundwater samples as per 329 IAC 10-21-2(b)(7)(c)(iii).

##### **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 exception of dissolved methane analysis, precision for organic analyses will be measured via the RPDs for matrix spike/matrix spike duplicate (MS/MSD) samples. Precision for inorganic analyses will be measured via RPDs for laboratory duplicates. Tables 3-1, 3-3, 3-5, 3-7, 3-9, and 3-11 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, and 3-12 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 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. 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.

**TABLE 3-1**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**MATRIX SPIKE AND LABORATORY DUPLICATE SAMPLES**  
**METALS ANALYSES**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

Chemical	Accuracy (%R)	Precision (RPD)
<b>METALS BY SW-846 METHOD 6010B (UNLESS OTHERWISE NOTED)</b>		
Antimony (SW-846 Method 6020)	75-125	20
Arsenic (SW-846 Method 6020)	75-125	20
Barium	75-125	20
Beryllium	75-125	20
Cadmium	75-125	20
Calcium	75-125	20
Chromium (total)	75-125	20
Cobalt	75-125	20
Copper	75-125	20
Iron	75-125	20
Lead (SW-846 Method 6020)	75-125	20
Lithium (SW-846 Method 6020)	75-125	20
Magnesium	75-125	20
Manganese	75-125	20
Mercury (SW-846 Method 7470A)	75-125	20
Nickel	75-125	20
Potassium	75-125	20
Selenium (SW-846 Method 6020)	75-125	20
Silver	75-125	20
Sodium	75-125	20
Thallium (SW-846 Method 6020)	75-125	20
Tin (SW-846 Method 6020)	75-125	20
Vanadium	75-125	20
Zinc	75-125	20

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

**TABLE 3-2**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**LABORATORY CONTROL SAMPLES**  
**METALS ANALYSES**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

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

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

**TABLE 3-3**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**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)
<b>VOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8260B</b>		
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
Toluene-D8 (surrogate)	75-125	NA <sup>(2)</sup>
Trichloroethene	54-141	20
Vinyl chloride	46-134	20
Xylenes (Total)	75-125	20

**TABLE 3-3**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**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)
1,2-Dichloroethane-D4 (surrogate)	62-139	NA
4-Bromofluorobenzene (surrogate)	75-125	NA

**ADDITIONAL VOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8015B**

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 Not applicable.

**TABLE 3-4**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**LABORATORY CONTROL SAMPLES**  
**VOLATILE ORGANIC COMPOUND ANALYSES**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

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

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

**TABLE 3-5**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES**  
**SEMIVOLATILE ORGANIC COMPOUND ANALYSES**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**  
**PAGE 1 OF 2**

Chemical	Accuracy (%R)	Precision (RPD)
<b>SEMIVOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8270C</b>		
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
Hexachlorocyclopentadiene	41-125	20

**TABLE 3-5**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES**  
**SEMIVOLATILE ORGANIC COMPOUND ANALYSES**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**  
**PAGE 2 OF 2**

Chemical	Accuracy (%R)	Precision (RPD)
<b>SEMIVOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8270C (CONTINUED)</b>		
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
2-Methylnaphthalene	41-125	20
Acenaphthylene	41-125	20
Acenaphthene	50-121	20
Anthracene	46-165	20
Benzo(a)anthracene	51-133	20
Benzo(a)pyrene	41-125	20
Benzo(b)fluoranthene	37-125	20
Benzo(k)fluoranthene	37-125	20
Benzo(g,h,i)perylene	34-149	20
Chrysene	55-133	20
Dibenzo(a,h)anthracene	50-125	20
Fluoranthene	47-125	20
Fluorene	48-139	20
Indeno(1,2,3-c,d)pyrene	27-160	20
Naphthalene	50-125	20
Phenanthrene	54-125	20
Pyrene	52-116	20

- 1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
- 2 Not applicable.

**TABLE 3-6**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**LABORATORY CONTROL SAMPLES**  
**SEMIVOLATILE ORGANIC COMPOUND ANALYSES**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

Chemical	Accuracy (%R)
<b>SEMIVOLATILE ORGANIC COMPOUNDS BY SW-846 METHOD 8270C</b>	
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
Acenaphthene	61-105
Pyrene	54-143

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

**TABLE 3-7**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**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)
<b>ORGANOCHLORINE PESTICIDES AND PCBs BY SW-846 METHOD 8081</b>		
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 <sup>(2)</sup>
Tetrachloro-m-xylene (surrogate)	25-139	NA

- 1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
- 2 Not applicable.

**TABLE 3-8**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**LABORATORY CONTROL SAMPLES**  
**ORGANOCHLORINE PESTICIDE AND PCB ANALYSES**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

<b>Chemical</b>	<b>Accuracy (%R)</b>
<b>ORGANOCHLORINE PESTICIDES AND PCBS BY SW-846 METHOD 8081</b>	
$\gamma$ -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 3-9**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLES AND SURROGATE SPIKES**  
**HERBICIDE ANALYSES**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

Chemical	Accuracy (%R)	Precision (RPD)
<b>HERBICIDES BY SW-846 METHOD 8151A</b>		
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
2,6-Dichlorobenzoic acid (surrogate)	45-93	NA <sup>(2)</sup>
2,4-Dichlorophenylacetic acid (surrogate)	50-101	NA

- 1 In-house QC limits provided by Laucks Testing Laboratories, Inc.
- 2 Not applicable.

**TABLE 3-10**

**QUALITY CONTROL LIMITS<sup>(1)</sup>  
LABORATORY CONTROL SAMPLES  
HERBICIDE ANALYSES  
NAVAL SURFACE WARFARE CENTER  
CRANE, INDIANA**

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

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

**TABLE 3-11**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**MATRIX SPIKE AND LABORATORY DUPLICATE SAMPLES**  
**MISCELLANEOUS PARAMETERS**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

Chemical	Accuracy (%R)	Precision (RPD)
<b>MISCELLANEOUS PARAMETERS</b>		
Alkalinity (SM 2320B)	92-106	10
Ammonia (EPA 350.1)	53-120	10
Bicarbonate (SM 2320B)	NA	NA
Carbonate (SM 2320B)	NA	NA
Chloride (SW-846 Method 9056)	73-121	11
Cyanide (SW-846 Method 9012A)	64-135	11
Fluoride (SW-846 Method 9056)	66-121	10
Nitrate (SW-846 Method 9056)	90-110	20
Sulfate (SW-846 Method 9056)	88-115	20
Sulfide (SW-846 Method 9034)	30-150 <sup>(2)</sup>	50 <sup>(2)</sup>
Total Dissolved Solids (EPA 160.1)	NA	30
Total Solids (EPA 160.3)	NA	30

- 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.  
 NA Not Applicable

**TABLE 3-12**  
**QUALITY CONTROL LIMITS<sup>(1)</sup>**  
**LABORATORY CONTROL SAMPLES**  
**MISCELLANEOUS PARAMETERS**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

Chemical	Accuracy (%R)
<b>MISCELLANEOUS PARAMETERS</b>	
Alkalinity (SM 2320B)	95-106
Ammonia (EPA Method 350.1)	75-125
Bicarbonate (SM 2320B)	NA
Carbonate (SM 2320B)	NA
Chloride (SW-846 Method 9056)	90-110
Cyanide (SW-846 Method 9012A)	75-125
Fluoride (SW-846 Method 9056)	66-121
Nitrate (SW-846 Method 9056)	90-110
Nitrite (SW-846 Method 9056)	90-110
Sulfate (SW-846 Method 9056)	80-120
Sulfide (SW-846 Method 9034)	30-150 <sup>(2)</sup>
Total Dissolved Solids (EPA 160.1)	93-107
Total Solids (EPA 160.3)	NA

- 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.  
 Not Not Applicable

Accuracy for organic analyses will be measured via the percent recoveries for surrogate spikes, MS/MSDs, and LCSs. Accuracy for inorganic analyses will be measured via percent recoveries for MSs and LCSs. Tables 3-1 through 3-12 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 90 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. The rationale of the sampling network is discussed in detail in Section 4 of the FSP (TtNUS, 1999).

### **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 TUNING CRITERIA**

Tuning criteria for the volatile and semivolatile organic compounds are provided in Tables 3-13 and 3-14, respectively.

### **3.7 LEVEL OF QC EFFORT**

Trip blank, rinsate 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. 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

**TABLE 3-13**  
**TUNING CRITERIA (BFB KEY IONS AND ION ABUNDANCE CRITERIA)**  
**VOLATILE ORGANIC COMPOUNDS**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

<b>Mass</b>	<b>Ion Abundance Criteria</b>
50	8.0 - 40.0 percent of mass 95
75	30.0 - 66.0 percent of mass 95
95	base peak, 100 percent relative abundance
96	5.0 - 9.0 percent of mass 95 (see note)
173	less than 2.0 percent of mass 174
174	50.0 - 120.0 percent of mass 95
175	4.0 - 9.0 percent of mass 174
176	93.0 - 101.0 percent of mass 174
177	5.0 - 9.0 percent of mass 176

Note: All ion abundances must be normalized to m/z 95, the nominal base peak, even though the ion abundance of m/z 174 may be up to 120.0 percent that of m/z 95.

**TABLE 3-14**  
**TUNING CRITERIA (DFTPP KEY IONS AND ION ABUNDANCE CRITERIA)**  
**SEMIVOLATILE ORGANIC COMPOUNDS**  
**NAVAL SURFACE WARFARE CENTER**  
**CRANE, INDIANA**

<b>Mass</b>	<b>Ion Abundance Criteria</b>
51	30.0 – 80.0 percent of mass 198
68	Less than 2.0 percent of mass 96
69	Present
70	Less than 2.0 percent of mass 69
127	25.0 – 75.0 percent of mass 198
197	Less than 1.0 percent of mass 198
198	Base peak, 100 percent relative abundance (see Note)
199	5.0 – 9.0 percent of mass 198
275	10.0 – 30.0 percent of mass 198
365	Greater than 0.75 percent of mass 198
441	Present but less than mass 443
442	40.0 – 110.0 percent of mass 198
443	15.0 – 24.0 percent of mass 442

Note: All ion abundances MUST be normalized to m/z 198, the nominal base peak, even though the ion abundance of m/z 442 may be up to 110 percent that of m/z 198.

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. 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, consisting of distilled water, are analyzed to check for interfering contaminants that could potentially be present in ambient air at the sampling site (e.g., volatile compounds or particulates). Ambient blanks will be collected based on conditions at the time of sampling at the discretion of the Field Operations Leader (FOL). 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 VOC samples.

Equipment rinsate blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after sampling and decontamination and prior to use. One rinsate blank will be collected per each type of sampling equipment used (i.e., pump, etc.) per day that sampling is conducted. If pre-cleaned, dedicated, or disposable sampling equipment is used, one rinsate blank per lot per type of equipment used must be collected as a "batch blank." Rinsate blanks are analyzed for the same chemical constituents as the associated environmental samples.

The collection of source water blanks is not anticipated since source water blanks are only applicable if new monitoring wells are installed or if non-dedicated bailers/bladder pumps are used for sampling. 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.

MS samples are investigative samples analyzed to provide information about the effect of the sample matrix on the digestion and measurement methodology. All MS samples 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. Specifically, four extra 40-milliliter (mL) bottles for VOCs and two extra 1000-mL bottles for all other organic analyses except nitrocellulose are required. Specific details regarding extra sample volume required for MS/MSD samples are provided for each analytical fraction in Tables 4-6 and 4-7 of the FSP. MS/MSD samples are further discussed in Section 8.0.

## 4.0 SAMPLING PROCEDURES

Field sampling procedures for the ground water monitoring program are discussed in detail in the FSP (TtNUS, 1999). The FSP addresses sampling procedures and additional field investigation tasks in the following sections:

- 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
- Water-Level Measurements - Section 4.2.2
- Aquifer Testing - Section 4.2.3
- Low-Flow Pump Installation - Section 4.2.4
- Well Purging - Section 4.2.5
- Sampling of Monitoring Wells - Section 4.2.6
- Decontamination of Field Sampling Equipment - Section 4.2.7
- Residue Waste Management - Section 4.2.8
- Sample Identification System - Section 4.2.9
- Sample Preservation, Shipping, and Handling - Section 4.2.10
- Chain-of-Custody/Documentation - Section 4.2.11
- 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

SOPs regarding sampling and record keeping are included as Appendix B to the FSP.

## 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. The reports indicate the number and type of containers submitted to the analytical laboratory. Pertinent notes, such as whether the sample was field filtered, or 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. 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 the comments column of the COC prior to sealing the cooler for shipment to

the laboratory. In accordance with NFESC guidelines, samples for chemical analysis will be sent (for next-day receipt) to the laboratory within 24 hours of collection.

Full details regarding sample COC (including use of custody seals and sample shipment protocols) are contained in SOP CTO 48-3, which is provided in Appendix B of the FSP. SOP CTO 48-4, also provided in Appendix B of the FSP, 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 TtNUS project central file.

## **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 the comments column of the COC report. In addition, the temperature reading will be recorded by Laucks Testing Laboratories, Inc., on the Supplemental Sample Receipt Log, as further discussed below. 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 Hydriion 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, will be completed by Laucks Testing Laboratories, Inc. 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 specific procedures for sample handling, storage, dispersment for analysis, and remnant disposal, are discussed in the laboratory SOPs.

## **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 FSP (TtNUS, 1999).

### **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.

Calibration procedures, frequency requirements, acceptance criteria, and conditions that require recalibration are described for each analytical procedure in the applicable analytical methods.

## 7.0 ANALYTICAL AND MEASUREMENT PROCEDURES

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. This laboratory has 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).

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/Eh, turbidity, and water level. Measurement of field parameters is discussed in Section 4.2 of the FSP. Calibration of field instruments is discussed in Section 4.5 of the FSP. As noted in Section 4.2.3 of the FSP, if insufficient hydraulic conductivity data are available, slug tests will also be conducted during the first year of ground water monitoring.

### 7.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES

Table 7-1 provides a summary of the laboratory analytical methods to be used during the ground water monitoring program.

#### 7.2.1 List of Project Target Compounds and Detection Limits

A complete list of the target compounds/analytes; project-specific 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 method provided in 40 CFR Part 136 Appendix B (FR Vol. 49, No. 209, pages 198-199). The IDLs provided for metals have been experimentally determined as described in the U.S. EPA Contract Laboratory Program (CLP) (ILM04.0; U.S. EPA, 1995). All environmental data will be reported to the analyte's laboratory-specific RL. 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.

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
Metals (except mercury) – total	SW-846 3010A or SW-846 3015	SW-846 6010B/6020
Metals (except mercury) – dissolved	--- <sup>(1)</sup>	SW-846 6010B/6020
Mercury - total & dissolved	SW-846 7470A	SW-846 7470A
Volatile Organic Compounds	SW-846 5030A	SW-846 8260B (with 25 mL purge)
Acetonitrile, Isobutyl alcohol, and Propionitrile	SW-846 5030A	SW-846 8015B
Semivolatile Organic Compounds	SW-846 3520C	SW-846 8270C
Organochlorine Pesticides and PCBs	SW-846 3510C	SW-846 8081
Herbicides	SW-846 8151A	SW-846 8151A
Alkalinity	---	SM 2320B
Ammonia	---	EPA <sup>(2)</sup> 350.1
Bicarbonate	---	SM 2320B
Carbonate	---	SM 2320B
Chloride	---	SW-846 9056
Cyanide	---	SW-846 9012A

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
Fluoride	---	SW-846 9056
Nitrate	---	SW-846 9056
Sulfate	---	SW-846 9056
Sulfite	SW-846 9030B	SW-846 9034
Total Dissolved Solids	---	EPA 160.1
Total Solids	---	EPA 160.3

- No preparation method is required for this parameter.
- 2 U.S. EPA, 1983. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020.

### **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.

## 8.0 INTERNAL QUALITY CONTROL CHECKS

Field-related QC checks are discussed in Section 3.0 of this QAPP and in Section 4.0 of the FSP (TtNUS, 1999). 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/Eh, and turbidity will include calibrating the instruments as described in Section 4.5 of the FSP and in the SOPs provided in Appendix B of the FSP. Assessment of field sampling precision and bias will be made by collection of field duplicates and rinsate blanks 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 4-6 and 4-7 of the FSP.

### 8.2 LABORATORY QUALITY CONTROL CHECKS

The identified subcontract laboratory has QC programs that ensure the reliability and validity of the analyses performed at the laboratory. The 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. In addition, the laboratory maintains SOPs regarding general laboratory QA procedures.

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. 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. For inorganic analyses, MS and **laboratory duplicate** analysis will be performed for every 20 environmental samples. Laboratory duplicates are prepared by splitting a sample aliquot into two portions and analyzing each portion following the same analytical procedures that are used for the environmental sample analyses. For volatile and extractable organic MSD analyses, a second sample aliquot 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 assessment monitoring analyte list (Table 1-3) 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 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 associated data will be flagged, 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. If there is insufficient sample available, or if holding times have passed, the laboratory will flag the associated data. 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 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. 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.) The spiking lists for volatile, semivolatile, pesticide/PCB, and herbicides analyses will contain analytes which represent each of the various classes of analytes on the target analyte list. 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 reparation or reanalysis is not possible, the data will be flagged and 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  $\pm 30$  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 analysis), and endrin/DDT degradation checks for pesticide analysis. Specific QC requirements for each of these QC checks are provided in the applicable SOPs.

## 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/Eh, and temperature. Only direct-read instrumentation will be employed in the field. Field measurements will be recorded in the site logbook and on sample logsheets immediately after measurements are taken. No calculations will be necessary to reduce these data. If an error is made in the logbook, 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. The 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)
- ORP/Eh - millivolts (mV)
- 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.

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:

- Metals - micrograms per liter ( $\mu\text{g/L}$ )
- Volatile organic compounds -  $\mu\text{g/L}$
- Semivolatile organic compounds -  $\mu\text{g/L}$
- Organochlorine pesticides/PCBs -  $\mu\text{g/L}$
- Herbicides -  $\mu\text{g/L}$
- Ammonia - milligrams per liter ( $\text{mg/L}$ )
- Alkalinity -  $\text{mg/L}$
- Bicarbonate -  $\text{mg/L}$
- Carbonate -  $\text{mg/L}$
- Chloride -  $\text{mg/L}$
- Sulfate -  $\text{mg/L}$
- Total dissolved solids -  $\text{mg/L}$
- Total solids -  $\text{mg/L}$
- Cyanide -  $\text{mg/L}$
- Nitrate -  $\text{mg/L}$
- Sulfide -  $\text{mg/L}$
- Fluoride -  $\text{mg/L}$

## 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. Validation of analytical data will be completed by the TtNUS Environmental Chemistry/Toxicology Department located in TtNUS's Pittsburgh office. Final review and approval of validation deliverables will be completed by the Department's Data Validation Coordinator.

Analytical results will be validated versus the applicable analytical methods, the SOPs, and the requirements of this QAPP. Validation of these data will conform to the National Functional Guidelines for Organic and Inorganic Data Review (U.S. EPA, 1994a, 1994b) to the greatest extent.

## **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. Field measurements will be transferred from the site logbook or sample logsheets 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 (i.e., field logbooks, sampling logbooks, and sample logsheets) 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). The laboratory report will include the laboratory method detection limit/instrument detection limit and laboratory reporting limit. Further details on the contents of the laboratory deliverable are provided in Appendix C.

Data will be handled electronically pursuant to the electronic deliverable requirements specified 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.

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.

Reporting of the analytical data will be performed as described in Section 5.0 of the FSP (TtNUS, 1999).

## 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.
- Data validators will review (on a timely basis) the chemical analytical data packages submitted by the laboratory. 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 internally by the Data Validation Coordinator prior to submittal to the TOM.
- 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

##### **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.

### **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.

### **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 B.
- 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**

#### **External Field Audit Responsibilities**

External field audits may be conducted by the IDEM.

#### **External Field Audit Frequency**

External field audits may be conducted at any time during field activities at the discretion of the IDEM.

#### **Overview of the External Field Audit Process**

External audit procedures are at the discretion of 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**

#### **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.

### **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. 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.

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

### **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. 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**

### **External Laboratory Audit Responsibilities**

External audits may be performed by the IDEM at their discretion. 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.

### **External Laboratory Audit Frequency**

An external laboratory audit may be conducted by IDEM prior to or during sampling and analysis activities.

### **Overview of the External Laboratory Audit Process**

External audit procedures are at the discretion of 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 FSP (TtNUS, 1999). The TtNUS equipment manager and the instrument operator will be responsible for ensuring that equipment is operating properly prior to use and that routine maintenance is performed and documented. Any problems encountered while operating the instrument will be recorded in the field logbook, including a description of the symptoms and corrective actions taken. If problems with the equipment are detected and service is required, the equipment will be logged, tagged, and segregated from equipment in proper working order. Use of the instrument will not be resumed until the problem is resolved.

### **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. 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 2

Instrument	Preventive Maintenance	Maintenance Frequency
GC/MS - Volatiles	Change pump oil.  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.	Yearly.  As needed.
GC/MS - Semivolatiles	Change injection port liner and septum, clip 5-10 cm from front of pre-column, ramp GC oven twice to 310 C.  Clean source, install new guard column, clean or replace tubing, replace bottom seal in injection port, replace o-ring in injection port.	Daily or as needed.  As needed.
GC - Volatiles by purge and trap (i.e., acetonitrile, isobutyl alcohol, propionitrile)	Change carrier and make-up gas filters.  Change trap, clean flame ionization detector (FID) jet, trim column.	As needed.  As needed.
GC - Organochlorine and organo-phosphorus pesticides/PCBs, herbicides	Swab electron capture (EC) detectors for radioactivity.  Change O <sub>2</sub> traps on gas lines.  Clean autosampler syringe.  Change injection port liner and septum.  Bake system, flush injection port, clip guard column, change analytical column, change carrier hydrocarbon trap.	Semi-annually.  Approx. semi-annually.  Approx. monthly.  Approx. every 100 injections.  As needed.
ICP/MS	Clean or change air filters, change pump oil.  Clean torch, replace nebulizer tips, replace pump tubing, replace injector, change cones.  Check mass calibration.  Check sensitivity.	Semi-annually.  As needed.  Every 2 weeks.  Daily.

TABLE 11-1  
 PREVENTIVE MAINTENANCE FOR ANALYTICAL INSTRUMENTS  
 NAVAL SURFACE WARFARE CENTER  
 CRANE, INDIANA  
 PAGE 2 OF 2

Instrument	Preventive Maintenance	Maintenance Frequency
ICP/AES	Service Intercooler.  Rinse and clean nebulizer cap and spray chamber.  Clean torch, vacuum filters.  Profile instrument, examine autosampler tubing and replace as needed.  Empty rinse container, fill rinse water reservoir.	Annually.  Monthly or as needed.  Bi-monthly.  Daily.  As needed.
Mercury Analyzer	Check and replace pump tubing, check and replace membrane, check and clean windows.	As needed.
Spectrophotometer	Clean sample compartment and entrance windows.  Check wavelength calibration.	Semi-annually.  Annually.
Ion Chromatograph	Replace pump seals.  Lubricate analytical pump motor.  Check chromatography module and all gas lines for leaks.  Clean conductivity detector cell electrodes, check cell calibration.  Replace bed supports, clean columns, clean AMMS (membrane suppresser), replace autosampler pipette tip.	Annually.  Semi-annually.  Every run.  Monthly.  As needed.
Lachat Ion Analyzer	Lubricate pump.  Replace pump tubing.  Change cadmium column.	Semi-annually.  As needed (~ 1 to 2 months)  As needed.
Refrigerators	Monitor temperature.	Daily.

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

Compliance with the quantitative QC objectives outlined in Tables 3-1 through 3-12 of Section 3.0 will be monitored via two separate mechanisms. Precision and accuracy will be assessed through data validation as discussed in Section 9.2. Compliance with the completeness objectives for field and laboratory data/measurements will be calculated by hand (field measurements) and electronically via a database subroutine (laboratory data). Equations to be used for the precision, accuracy, and completeness assessment are outlined in the remainder of this section.

### 12.1 ACCURACY ASSESSMENT

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 compound and kept on matrix- and analyte-specific bases. The %R for a spiked sample is calculated by using the following formula:

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

### 12.2 PRECISION ASSESSMENT

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. Duplicate samples are prepared by dividing an environmental sample into equal aliquots. MSD samples are prepared by dividing an environmental sample into equal aliquots and then spiking each of the aliquots with a known amount of analyte. The duplicate or MSD samples are then included in the analytical sample set. The splitting of the sample allows the analyst to determine the precision of the preparation and analytical techniques associated with the duplicate samples. The RPD between the sample (or spike) and duplicate (or duplicate spike) is calculated and plotted.

The RPD is calculated according to the following formula:

$$\text{RPD} = \frac{\text{Amount in Sample} - \text{Amount in Duplicate}}{0.5 (\text{Amount in Sample} + \text{Amount in Duplicate})} \times 100$$

### 12.3 COMPLETENESS ASSESSMENT

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 by the following equation:

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

## **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 onsite approval by NSWC Crane personnel. 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 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:

- QC data are outside established warning or control limits.
- Method blank analyses yield concentrations of target analytes above acceptable levels.

**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

Others as required \_\_\_\_\_

Quality Assurance Officer

Task Order Manager

Field Operations Leader

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- 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.

### **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 four primary 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, written weekly reports summarizing accomplishments and QA/QC issues during the field investigation will be prepared by the FOL. 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.

### 14.1 CONTENTS OF PROJECT QUALITY ASSURANCE REPORTS

The contents of the specific QA reports are as follows. 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, 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 weekly reports 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. Since MDLs/IDLs/RLs, as applicable, will be included in the analytical data packages for NSWC Crane samples, it is not necessary for the laboratories 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 - weekly during the course of the each sampling event associated with the ground water monitoring program; and
- (3) monthly progress reports - monthly;
- (4) laboratory QA reports - as required based on QC limit updates.

## **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, QAM, TOM, and Laboratory Services Coordinator are provided with copies of the QA report. Weekly field progress reports 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 IDEM 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. Copies of any cited QA reports will be provided to the IDEM immediately upon request.

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**APPENDIX A**

**HUMAN RISK-BASED CRITERIA**

**TABLE A-1**  
**HUMAN HEALTH-BASED CRITERIA**  
**NSWC CRANE, CRANE, INDIANA**  
**PAGE 1 OF 4**

Chemical	IDEM Constituent Number <sup>(1)</sup>		Region IX PRG <sup>(2)</sup>		Federal MCL <sup>(3)</sup> (ug/L)	Target Level <sup>(4)</sup> (ug/L)
	Table 1A	Table 2	Classification	Value		
<b>EXPLOSIVES</b>						
1,3,5-TRINITROBENZENE		227	N	1100	NA	1100
1,3-DINITROBENZENE		106	N	3.7	NA	3.7
2,4-DINITROTOLUENE		109	N	73	NA	73
2,6-DINITROTOLUENE		110	N	37	NA	37
NITROBENZENE		172	N	3.4	NA	3.4
<b>METALS</b>						
ANTIMONY		13,14	N	15	6	6
ARSENIC		15,16	C	0.45	50	50
BARIUM		17,18	N	2600	2000	2000
BERYLLIUM		26,27	C	0.16	4	4
CADMIUM	3	41,42	N	18	5	5
CHROMIUM (TOTAL)	9	56,57			100	100
COBALT		59,60	N	2200	NA	2200
COPPER	10	61,62	N	1400	1300 <sup>(5)</sup>	1300 <sup>(5)</sup>
LEAD		141142		4	15 <sup>(5)</sup>	15 <sup>(5)</sup>
LITHIUM	--	--	N	730	NA	730
MERCURY		145146	N		2	2
NICKEL		166167	N	730	100	100
SELENIUM		198199	N	180	50	50
SILVER		200201	N	180	100 <sup>(6)</sup>	100 <sup>(6)</sup>
SODIUM	26					
THALLIUM		211212	N		2	2
TIN			N	22,000	NA	22,000
VANADIUM		228229	N	260	NA	260
ZINC	38	233234	N	11000	5000	5000
<b>VOLATILE ORGANIC COMPOUNDS</b>						
1,1,1-TRICHLOROETHANE	32	219	N	790	200	200
1,1,1,2-TETRACHLOROETHANE	28	207	C	4.3	NA	4.3
1,1,2,2-TETRACHLOROETHANE	29	208	C	0.55	NA	0.55
1,1,2-TRICHLOROETHANE	33	220	C	2	5	5
1,2,3-TRICHLOROPROPANE		225	C	0.016	NA	0.016
1,1-DICHLOROETHANE	13	84	N	810	NA	810
1,1-DICHLOROETHENE	15	86	C	0.46	7	7
1,1-DICHLOROPROPENE		94			NA	
1,2-DIBROMO-3-CHLOROPROPANE		75	C	0.48	0.2	0.2
1,2-DIBROMOETHANE		76	C	0.0076	NA	0.0076
1,2-DICHLOROETHANE	14	85	C	1.2	5	5
1,2-DICHLOROPROPANE	18	91	C	1.6	NA	1.6
1,3-DICHLOROPROPANE		92			NA	
2,2-DICHLOROPROPANE		93			NA	
2-BUTANONE		153	N	1900	NA	1900
2-CHLORO-1,3-BUTADIENE		55	N	14	NA	14
2-HEXANONE		134	N		NA	
4-METHYL-2-PENTANONE		159	N	160	NA	160
ACETONE		3	N	610	NA	610
ACETONITRILE		4	N	71	NA	71
ACROLEIN		7	N	0.042	NA	0.042
ACRYLONITRILE		8	C	37	NA	37
ALLYL CHLORIDE		10	N	1800	NA	1800
BENZENE	2	19	C	3.9	5	5
BROMOCHLOROMETHANE		36			NA	
BROMODICHLOROMETHANE		37	C	1.8	100	100
BROMOFORM		38	C	85	100	100
BROMOMETHANE	22	150	N	8.7	NA	8.7
CARBON DISULFIDE		43	N	1000	NA	1000
CARBON TETRACHLORIDE	4	44	C	1.7	5	5
CHLOROBENZENE	6	47	N	39	100	100
CHLOROETHANE	7	50	C		NA	
CHLOROFORM	8	51	C	1.6	100	100
CHLOROMETHANE		151	C	15	NA	15

TABLE A-1

HUMAN HEALTH-BASED CRITERIA  
NSWC CRANE, CRANE, INDIANA  
PAGE 2 OF 4

Chemical	IDEM Constituent Number <sup>(1)</sup>		Region IX PRG <sup>(2)</sup>		Federal MCL <sup>(3)</sup> (ug/L)	Target Level <sup>(4)</sup> (ug/L)
	Table 1A	Table 2	Classification	Value		
CIS-1,2-DICHLOROETHENE	16	87	N	61	70	70
CIS-1,3-DICHLOROPROPENE	19	95	C	0.81	NA	0.81
DIBROMOCHLOROMETHANE		74	C	10	100	100
DIBROMOMETHANE		160	C	0.0076	NA	0.0076
DICHLORODIFLUOROMETHANE		83	N	390	NA	390
ETHYLBENZENE	21	120	N	1300	700	700
ETHYL METHACRYLATE		121	N	550	NA	550
ISOBUTANOL		136	N	1800	NA	1800
METHACRYLONITRILE		147	N	1	NA	1
METHYLENE CHLORIDE	24	161	C	43	5	5
METHYL IODIDE		154			NA	
METHYL METHACRYLATE		155	N	1400	NA	1400
PROPIONITRILE		195			NA	
STYRENE	25	203	N	1600	100	100
TETRACHLOROETHENE	30	209	C	11	5	5
TOLUENE	31	215	N	720	1000	1000
TRANS-1,2-DICHLOROETHENE	17	88	N	120	100	100
TRANS-1,3-DICHLOROPROPENE	20	96	C	0.81	NA	0.81
1,4-DICHLORO-2-BUTENE		82	C	0.012	NA	0.012
TRICHLOROETHENE	34	221	C	16	5	5
TRICHLOROFLUOROMETHANE	35	222	N	1300	NA	1300
VINYL ACETATE		230	N	410	NA	410
VINYL CHLORIDE	36	231	C	0.2	2	2
XYLENES, TOTAL	37	232	N	1400	10000	10000
<b>SEMIVOLATILE ORGANIC COMPOUNDS</b>						
1,2,4,5-TETRACHLOROBENZENE		206	N	11	NA	11
1,2,4-TRICHLOROBENZENE		218	N	190	70	70
1,2-DICHLOROBENZENE	11	78	N	370	600	600
1,3-DICHLOROBENZENE		79	N	17	NA	17
1,4-DICHLOROBENZENE	12	80	C	4.7	75	75
1,4-NAPHTHOQUINONE		163			NA	
1,4-PHENYLENEDIAMINE		191	N	6900	NA	6900
1-NAPHTHYLAMINE		164			NA	
2,3,4,6-TETRACHLOROPHENOL		210	N	1100	NA	1100
2,4,5-TRICHLOROPHENOL		223	N	3700	NA	3700
2,4,6-TRICHLOROPHENOL		224	C	61	NA	61
2,4-DICHLOROPHENOL		89	N	110	NA	110
2,4-DIMETHYLPHENOL		104	N	730	NA	730
2,4-DINITROPHENOL		108	N	73	NA	73
2,6-DICHLOROPHENOL		90			NA	
2-ACETYLAMINOFLUORENE		6			NA	
2-CHLORONAPHTHALENE		52	N	490	NA	490
2-CHLOROPHENOL		53	N	38	NA	38
2-METHYLNAPHTHALENE		157	N		NA	
2-METHYLPHENOL		64	N	1800	NA	1800
2-NAPHTHYLAMINE		165	C		NA	
2-NITROANILINE		169	N	2.2	NA	2.2
2-NITROPHENOL		173			NA	
3,3'-DICHLOROBENZIDINE		81	C	1.5	NA	1.5
3,3'-DIMETHYLBENZIDINE		103	C	0.073	NA	0.073
3-METHYLCHOLANTHRENE		152			NA	
3-METHYLPHENOL		63	N	1800	NA	1800
3-NITROANILINE		170	N		NA	
4,6-DINITRO-2-METHYLPHENOL		107	N		NA	
4-AMINOBIIPHENYL		11			NA	
4-BROMOPHENYL PHENYL ETHER		39	N		NA	
4-CHLORO-3-METHYLPHENOL		49			NA	
4-CHLOROANILINE		46	N	150	NA	150
4-CHLOROPHENYL PHENYL ETHER		54			NA	
4-METHYLPHENOL		65	N	180	NA	180
4-NITROANILINE		171	N		NA	

TABLE A-1

HUMAN HEALTH-BASED CRITERIA  
NSWC CRANE, CRANE, INDIANA  
PAGE 3 OF 4

Chemical	IDEM Constituent Number <sup>(1)</sup>		Region IX PRG <sup>(2)</sup>		Federal MCL <sup>(3)</sup> (ug/L)	Target Level <sup>(4)</sup> (ug/L)
	Table 1A	Table 2	Classification	Value		
4-NITROPHENOL		174	N	2300	NA	2300
5-NITRO-O-TOLUIDINE		183			NA	
7,12-DIMETHYLBENZ(A)ANTHRACENE		102			NA	
ACENAPHTHENE		2	N	370	NA	370
ACENAPHTHYLENE		1			NA	
ACETOPHENONE		5	N	0.042	NA	0.042
ANTHRACENE		12	N	1800	NA	1800
BENZO(A)ANTHRACENE		20	C	0.92	NA	0.92
BENZO(A)PYRENE		24	C	0.092	0.2	0.2
BENZO(B)FLUORANTHENE		21	C	0.92	NA	0.92
BENZO(G,H,I)PERYLENE		23			NA	
BENZO(K)FLUORANTHENE		22	C	9.2	NA	9.2
BENZYL ALCOHOL		25	N	11000	NA	11000
BIS(2-CHLOROETHOXY)METHANE		32			NA	
BIS(2-CHLOROETHYL)ETHER		33	C	0.098	NA	0.098
BIS(2-CHLOROISOPROPYL) ETHER		34	C	2.7	NA	2.7
BIS(2-ETHYLHEXYL)PHTHALATE		35	C	48	6	6
BUTYLBENZYL PHTHALATE		40	N	7300	NA	7300
CHLOROBENZILATE		48	C	2.5	NA	2.5
CHRYSENE		58	C	92	NA	92
DIALATE		71	C	11	NA	11
DI-N-BUTYL PHTHALATE		77	N	3700	NA	3700
DI-N-OCTYL PHTHALATE		112	N	730	NA	730
DIBENZO(A,H)ANTHRACENE		72	C	0.092	NA	0.092
DIBENZOFURAN		73	N	24	NA	24
DIETHYL PHTHALATE		98	N	29000	NA	29000
DIMETHOATE		100	N	7.3	NA	7.3
P-(DIMETHYLAMINO)AZOBENZENE		101			NA	
DIMETHYL PHTHALATE		105	N	365000	NA	365000
DIPHENYLAMINE		113	N	910	NA	910
ETHYL METHANE SULFONATE		122			NA	
FLUORANTHENE		124	N	1500	NA	1500
FLUORENE		125	N	240	NA	240
HEXACHLOROBENZENE		129	C	0.42	1	1
HEXACHLOROBUTADIENE		130	C	8.6	NA	8.6
HEXACHLOROCYCLOPENTADIENE		131	N	260	50	50
HEXACHLOROETHANE		132	C	48	NA	48
HEXACHLOROPROPENE		133			NA	
INDENO(1,2,3-CD)PYRENE		135	C	0.92	NA	0.92
ISODRIN		137			NA	
ISOPHORONE		138	C	710	NA	710
ISOSAFROLE		139			NA	
METHAPYRILENE		148			NA	
METHYL METHANE SULFONATE		156			NA	
N-NITROSODI-N-BUTYLAMINE		175	C	0.02	NA	0.02
N-NITROSODIETHYLAMINE		176	C	0.0045	NA	0.0045
N-NITROSODIMETHYLAMINE		177	C	0.013	NA	0.013
N-NITROSODIPHENYLAMINE		178	C	140	NA	140
N-NITROSO-DI-N-PROPYLAMINE		179	C	0.096	NA	0.096
N-NITROSO-N-METHYLETHYLAMINE		180	C	0.031	NA	0.031
N-NITROSOPIPERIDINE		181			NA	
N-NITROSOPIRROLIDINE		182	C	0.32	NA	0.32
NAPHTHALENE		162	N	6.2	NA	6.2
PENTACHLOROBENZENE		185	N	29	NA	29
PENTACHLORONITROBENZENE		186	C	2.6	NA	2.6
PENTACHLOROPHENOL		187	C	5.6	1	1
PHENACETIN		188			NA	
PHENANTHRENE		189			NA	
PHENOL		190	N	22000	NA	22000
PRONAMIDE		194	N	2700	NA	2700
PYRENE		196	N	180	NA	180

TABLE A-1

**HUMAN HEALTH-BASED CRITERIA  
NSWC CRANE, CRANE, INDIANA  
PAGE 4 OF 4**

Chemical	IDEM Constituent Number <sup>(1)</sup>		Region IX PRG <sup>(2)</sup>		Federal MCL <sup>(3)</sup> (ug/L)	Target Level <sup>(4)</sup> (ug/L)
	Table 1A	Table 2	Classification	Value		
SAFROLE		197			NA	
THIONAZIN		99			NA	
O-TOLUIDINE		216			NA	
O,O,O-TRIETHYL PHOSPHOROTHIOATE		226			NA	
<b>ORGANOCHLORINE PESTICIDES AND PCBs</b>						
ALDRIN		9	C	0.04	NA	0.04
ALPHA-BHC		28	C	0.11	NA	0.11
BETA-BHC		29	C	0.37	NA	0.37
CHLORDANE		45	C	1.9	2	2
4,4'-DDD		68	C	2.8	NA	2.8
4,4'-DDE		69	C	2	NA	2
4,4'-DDT		70	C	2	NA	2
DELTA-BHC		30			NA	
DIELDRIN		97	C	0.042	NA	0.042
ENDOSULFAN I		115	N	220	NA	220
ENDOSULFAN II		116	N	220	NA	220
ENDOSULFAN SULFATE		117	N		NA	
ENDRIN		118	N	11	2	2
ENDRIN ALDEHYDE		119	N		NA	
GAMMA-BHC (LINDANE)		31	C	0.52	0.2	0.2
HEPTACHLOR		127	C	0.15	NA	0.15
HEPTACHLOR EPOXIDE		128	C	0.074	NA	0.074
KEPONE		140	C	0.037	NA	0.037
METHOXYCHLOR		149	N	180	40	40
TOXAPHENE		217	C	0.61	3	3
AROCLOR-1016		193	N	2.6	0.5 <sup>(6)</sup>	0.5 <sup>(6)</sup>
AROCLOR-1221		193	C	26	0.5 <sup>(6)</sup>	0.5 <sup>(6)</sup>
AROCLOR-1232		193	C	26	0.5 <sup>(6)</sup>	0.5 <sup>(6)</sup>
AROCLOR-1242		193	C	26	0.5 <sup>(6)</sup>	0.5 <sup>(6)</sup>
AROCLOR-1248		193	C	26	0.5 <sup>(6)</sup>	0.5 <sup>(6)</sup>
AROCLOR-1254		193	N	0.73	0.5 <sup>(6)</sup>	0.5 <sup>(6)</sup>
AROCLOR-1260		193	C	26	0.5 <sup>(6)</sup>	0.5 <sup>(6)</sup>
<b>ORGANOPHOSPHATE PESTICIDES</b>						
DISULFOTON		114	N	1.5	NA	1.5
ETHYL PARATHION		184	N	220	NA	220
FAMPHUR		123			NA	
METHYL PARATHION		158	N	9.1	NA	9.1
PHORATE		192	N	7.3	NA	7.3
<b>HERBICIDES</b>						
2,4-D		67	N	370	70	70
2,4,5-T		205	N	370	NA	370
2,4,5-TP (SILVEX)		202	N		50	50
DINOSEB		111	N	37	NA	37
<b>MISCELLANEOUS PARAMETERS</b>						
AMMONIA	1		N			
CHLORIDE	5					
CYANIDE		66	N	730	200	200
NITRATE		168	N	10000	NA	10000
SULFATE	27					
SULFIDE		204			NA	

## Notes:

- 1 IDEM Constituent Number as presented in 329 IAC 10-21-15 (Tables 1A and 1B) and 329 IAC 10-21-16 (Table 2).
- 2 U.S. EPA Region IX Preliminary Remedial Goals (PRGs) at a cancer risk level of 1E-5 for carcinogens, or a hazard level of 1.0 for noncarcinogens.
- 3 Safe Drinking Water Act Federal Maximum Contaminant Level (MCL) (U.S. EPA, October 1996).
- 4 Target level is Federal MCL, where defined. If no MCL is available, then target level is the Region IX PRG.
- 5 Action Level.
- 6 Total PCBs.

**APPENDIX B**  
**FIELD AUDIT CHECKLIST**



# Tetra Tech NUS, Inc.

## FIELD AUDIT CHECKLIST

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### QA/QC Procedures

1. Were any field observations, deficiencies, nonconformances, or complaints recorded by the site QA/QC Officer or other personnel?  
If so, summarize below.

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2. Based on personnel interviews, did any variances from the project planning documents occur? If so, what were they?

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3. Were field modification records pertinent to the above initiated in an appropriate manner?

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4. If applicable, were corrective action plans implemented (according to proper procedure)?

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5. Were field QC samples obtained with the frequency specified in the QAPP or FSP?

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6. Were field duplicates submitted "blind" to the laboratory?

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# FIELD AUDIT CHECKLIST

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7. Are sufficient replicate aliquots of samples designated to the laboratory for the matrix spike/duplicate analyses specified in the QAPP, or FSP?

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## Groundwater Sampling

8. Were all monitoring wells properly purged and recovered prior to sampling?

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9. When applicable, were well volumes calculated as described in the FSP?

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10. If samples were acquired by a pump, was the pump or intake tubing lowered to midscreen (middle of open section of uncased wells) for sample acquisition?

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## Calibration and Use of Field Monitoring Equipment

11. Were the following calibration criteria observed:

- calibration according to manufacturer's instructions \_\_\_\_\_
- calibration only by qualified individuals \_\_\_\_\_
- calibrated and operationally checked prior to project assignment \_\_\_\_\_
- use of certified/traceable standards \_\_\_\_\_
- calibration documented \_\_\_\_\_
- if applicable, maintenance documented \_\_\_\_\_

## Equipment Decontamination Procedures

12. Verify that all non-dedicated sampling equipment and water-level indicators are subjected to decontamination per the sequence outlined in the FSP.

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# FIELD AUDIT CHECKLIST

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## Waste Handling Procedures

13. Do the project planning documents provide for the disposal of Personal Protective Equipment (PPE) by double-bagging and discard?

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14. By what method are PPE disposed of?

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15. If applicable, were used spill-containment materials containerized or otherwise acceptably disposed of?

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## Sample Handling

16. Are the appropriate containers provided by the laboratory being used for each fractional type of sample?

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17. Has a Trip Blank been submitted with each cooler of VOC samples?

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18. Have equipment rinsate blanks of the proper type and frequency been obtained?

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19. Have Source Water Blanks been obtained from water sources applicable to the field effort?

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## FIELD AUDIT CHECKLIST

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20. Have the rinsate and other field blanks been designated for the same analyses as the associated samples?

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21. Have all samples been properly preserved in accordance with the project planning documents?

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22. Has sample custody been maintained with regard to the following criteria:

A sample is under an individual's custody if:

- it is in the individual's actual possession
- it is in the individual's view after possession
- it was locked up to prevent tampering
- it was placed in a designated and identified secure area

(The sample remains in the individual's custody until it is entrusted to a laboratory courier or commercial express carrier.)

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### Documentation

23. Are all sample logs complete?

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24. Have chain-of-custody (COC) forms been filled out for all samples, including field quality control samples?

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## FIELD AUDIT CHECKLIST

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25. Have the COC forms been signed by the appropriate individual at each step that the samples are relinquished?

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26. Have the COC forms been filled-out using black waterproof ink?

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27. If the COC form was corrected, was a line drawn through the information and was the change dated and initialed? (Use of white-out or erasure is not permitted.)

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28. Have the appropriate analyses (per the project planning documents) been properly designated for each sample on the chain-of-custody form?

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29. Have all sample labels been filled out appropriately and completely?

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30. Have all sample labels been filled out using indelible ink?

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31. Have the samples been identified according to the scheme depicted in the project planning documents?

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32. Do the sample identifications agree between the sample log, field notebook, sample label and chain-of-custody form?

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# FIELD AUDIT CHECKLIST

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33. Has the following information (at minimum) been recorded in the site logbook:

- arrival/departure of site visitors
- arrival/departure of equipment
- sample pickup, COC form nos., carrier company, time
- sampling activities/sample logsheet nos.
- health and safety issues

34. Is the site logbook a bound notebook with consecutively numbered pages that cannot be easily removed?

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35. Does the cover of the site logbook contain the following information?

project name \_\_\_\_\_  
project number \_\_\_\_\_  
contractor name \_\_\_\_\_  
sequential book number \_\_\_\_\_  
start date \_\_\_\_\_  
end date \_\_\_\_\_

36. Has the following information been recorded at the beginning of each day?

date \_\_\_\_\_  
start time \_\_\_\_\_  
weather conditions \_\_\_\_\_  
all field personnel present \_\_\_\_\_  
any visitor present \_\_\_\_\_

37. Do the site logbook entries summarize the daily activities and refer to other site notebooks or logsheets where applicable?

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38. Have all site logbook entries been made in black indelible ink?

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## FIELD AUDIT CHECKLIST

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39. If a logbook entry was corrected, was a line drawn through the information and was the change dated and initialed? (Use of white-out or erasure is not permitted.)

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40. Did the individual making the logbook entry signed it?

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41. Did the Field Operations Leader sign all logbook pages utilized that day at the end of each day?

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**APPENDIX C**

**ANALYTICAL DOCUMENTATION**

## **ANALYTICAL DOCUMENTATION – LEVEL III ADO**

The analytical documentation should include an organized summary of the final results, a copy of signed chain-of-custody for each sample, and all quality control documentation, including a report case narrative that explains any QA/QC or analysis problems encountered and the corrective actions taken.

Specifically, analytical documentation should include the following for each type of analysis:

### **I. Metals by Atomic Absorption Spectroscopy**

#### **A. Documentation of analysis dates and methods showing:**

1. Sampling date,
2. Facility sample number and lab sample number,
3. Preservative used (when applicable),
4. Extraction date (when applicable),
5. Digestion date,
6. Analysis date and time of day,
7. Extraction, digestion, and analytical method numbers,
8. Report date, and
9. Chain-of-custody report.

#### **B. Results of method and lab blanks, including detection limits.**

#### **C. Results of lab replicates (when applicable).**

#### **D. Results of instrument calibration (three-point or five-point) documented by:**

1. Calibration curve for each metal,
2. Correlation coefficient for each metal, and
3. Standard deviation and relative standard deviation.

#### **E. Initial calibration verification and continuing calibration verification documented by:**

1. Results of verification standard analysis (concentration of standard) and
2. Percent recoveries.

#### **F. Results of matrix spike/matrix spike duplicate analysis documented by:**

1. Concentration of analyte in original sample (before spiking),
2. Amount of spike for each component,
3. Spiked sample result for each component,
4. Percent recovery of each component,
5. Relative percent difference between spike and spike duplicate of each component, and
6. Analysis date and time.

#### **G. Results of Method of Standard Additions (when applicable).**

#### **H. Results of Laboratory Control Sample.**

#### **I. Detection limit summary report.**

#### **J. Holding times summary report**

## **II. Metals by Inductively Coupled Plasma Spectroscopy**

- A. Documentation of analysis dates and methods showing:
  - 1. Sampling date,
  - 2. Facility sample number and lab sample number,
  - 3. Preservative used (when applicable),
  - 4. Extraction date (when applicable),
  - 5. Digestion date,
  - 6. Analysis date and time of day,
  - 7. Extraction, digestion, and analytical method numbers,
  - 8. Report date, and
  - 9. Chain-of-custody report.
- B. Results of method and lab blanks, including detection limits.
- C. Results of lab replicates (when applicable).
- D. Results of instrument calibration (three-point or five-point) documented by:
  - 1. Calibration curve for each metal,
  - 2. Correlation coefficient for each metal, and
  - 3. Standard deviation and relative standard deviation.
- E. Inductively Coupled Plasma (ICP) linear range report.
- F. Initial calibration verification and continuing calibration verification documented by:
  - 1. Results of verification standard analysis (concentration of standard) and
  - 2. Percent recoveries.
- G. Interference check sample results.
- H. ICP serial dilution results (when applicable).
- I. ICP interelement correction factors.
- J. Results of matrix spike/matrix spike duplicate analysis documented by:
  - 1. Concentration of analyte in original sample (before spiking),
  - 2. Amount of spike for each component,
  - 3. Spike sample result for each component,
  - 4. Percent recovery of each component,
  - 5. Relative percent difference between spike and spike duplicate of each component, and
  - 6. Analysis date and time.
- K. Results of Method of Standard Additions (when applicable).
- L. Results of Laboratory Control Sample
- M. Detection limit summary report.
- N. Holding times summary report.

### **III. General Inorganic Analysis:**

- A. Provide dates and methods showing:
  - 1. Sampling date,
  - 2. Facility sample number and lab sample number,
  - 3. Preservative used (when applicable),
  - 4. Extraction date (when applicable),
  - 5. Digestion date (when applicable),
  - 6. Analysis date and time of day,
  - 7. Extraction, digestion and analytical method numbers,
  - 8. Report date, and
  - 9. Chain-of-custody report
- B. Results of method and lab blanks, including detection limits.
- C. Results of lab replicates.
- D. Results of instrument or standard calibration including:
  - 1. Calibration curve,
  - 2. Correlation coefficient, and
  - 3. Standard deviation and relative standard deviation data (when applicable).
- E. Continuing calibration verification including:
  - 1. Results of verification standard (concentration of standard) and
  - 2. Percent recovery.
- F. Results of matrix spike/matrix spike duplicate including:
  - 1. Concentration of analyte in original sample (before spiking),
  - 2. Amount of spike for each component,
  - 3. Spiked sample result for each component,
  - 4. Percent recovery of each component,
  - 5. Relative percent difference between spike and spike duplicate of each component, and
  - 6. Analysis date and time.
- G. Results of Lab Control Sample.
- H. Holding times summary report.
- I. Detection limit summary report.

### **IV. Volatile and Semivolatile Organics by Gas Chromatography (GC)**

- A. Documentation of analysis dates and methods showing:
  - 1. Sampling date,
  - 2. Facility sample number and lab sample number,
  - 3. Extraction date (when applicable),
  - 4. Analysis date and time of day,
  - 5. Extraction and analytical method numbers,
  - 6. Report date, and
  - 7. Chain-of-custody report.

- B. Results of five-point external standard calibration documented by:
  - 1. Retention time for each compound,
  - 2. Calibration curve and response factor,
  - 3. Average response factor, and
  - 4. Percent relative standard deviation for each compound in standard.
- C. Continuing calibration results documented by:
  - 1. Response factors of each compound,
  - 2. Average response factor from calibration curve for each compound, and
  - 3. Percent difference of each response factor.
- D. Summary of surrogate recoveries for each sample.
- E. Matrix spike/matrix spike duplicate results documented by:
  - 1. Concentration of analyte in original sample (before spiking),
  - 2. Amount of spike for each component,
  - 3. Spiked sample result for each component,
  - 4. Percent recover of each component,
  - 5. Relative percent difference between spike and spike duplicate of each component, and
  - 6. Analysis date and time.
- F. Results of dual column confirmation (when applicable).
- G. Blank analysis summary report.
- H. Holding time summary report.
- I. Detection Limit Summary Report.
- V. **Volatile and Semivolatile Organics by gas Chromatography/Mass Spectroscopy (GC/MS):**
  - A. Documentation of analysis dates and methods showing:
    - 1. Sampling date,
    - 2. Facility sample number and lab sample number,
    - 3. Preservative used (when applicable),
    - 4. Extraction date (when applicable),
    - 5. Analysis date and time of day,
    - 6. Extraction and analytical method numbers,
    - 7. Report date, and
    - 8. Chain-of-custody report.
  - B. Method blank summary sheet and results, including detection limits.
  - C. Results of Bromofluorobenzene (BFB) or Decafluorotriphenylphosphine (DFTPP) tuning criteria.
  - D. Initial calibration results documented by the following:
    - 1. Total ion chromatogram,
    - 2. Summary of retention times for all target compounds,
    - 3. Response factors for each target compound in the calibration standards,
    - 4. Average response factor fore ach compound,
    - 5. Percent relative standard deviations for the five concentrations,

6. System performance and calibration check compounds clearly marked, and
7. Date and time of injection.

E. Continuing calibration results documented by:

1. Response factors of each compound in the standard,
2. Average response factor from initial calibration for each compound,
3. Percent difference of each response factor,
4. System performance and calibration check compounds clearly marked, and
5. Date and time of injection.

F. Summary of internal standards for each sample documented by:

1. Area of primary peak for each standard from the 12 hour standard and the respective retention time (RT),
2. Area of primary peak for each standard from each sample and the respective RT, and
3. Upper and lower quality control limits for peak area and RT clearly identified.

G. Summary of surrogate recoveries for each sample.

H. Results of matrix spike/matrix spike duplicate documented by:

1. Concentration of analyte in original sample (before spiking),
2. Amount of spike for each component,
3. Spiked sample result for each component,
4. Percent recovery of each component,
5. Relative percent difference between spike and spike duplicate of each component, and
6. Analysis date and item.

I. Results of Tentatively Identified Compounds (TICs) documented by:

1. Name of TIC (list as unknown if unidentifiable),
2. Estimated concentration using closest internal standard,
3. For volatiles, list first ten (10) TICs (even if unknown), and
4. For semivolatiles, list for first twenty (20) TICs (even if unknown).

J. Holding time summary report, including holding time for extracts prior to analysis (when applicable)

K. Detection limit summary report.

**VI. Gas Chromatography for PCB/Pesticide/Herbicide Analysis:**

A. Documentation of analysis dates and methods showing:

1. Sampling date,
2. Facility sample number and lab sample number,
3. Extraction date,
4. Analysis date and time of day,
5. Extraction and analytical method number(s),
6. Report date, and
7. Chain-of-custody report.

B. Results of external standard initial calibration for:

1. Single component analytes (three-point or five-point calibration) documented by:

- a. Calibration chromatograms,
  - b. Summary of RTs and RT windows for each standard,
  - c. Summary of calibration factors calculated for each concentration including mean and percent relative standard deviation for each standard, and
  - d. Percent breakdown of Endrin and DDT.
2. Multi-component analytes (one point calibration allowable if 3 to 5 point has been established) documented by:
- a. RTs and RT windows for each major peak of each analyte (at each concentration, if applicable),
  - b. Calibration factor for each major peak of each analyte (at each concentration, if applicable), and
  - c. Calibration chromatograms.
- C. If internal standards are used, include as documentation:
1. Identification of internal standards used and compounds of interest associated with each, and
  2. Summary of RT windows and calibration factors.
- D. Continuing calibration results documented by pesticide calibration verification summary including:
1. RT windows and relative percent difference for analytes listed,
  2. Percent breakdown of Endrin, DDT, and combined breakdown, and
  3. Summary of calibration factors and percent relative standard deviation.
- E. Summary of surrogate recoveries for each sample.
- F. Matrix spike/matrix spike duplicate results documented by:
1. Concentration of analyte in original sample (before spiking),
  2. Amount of spike for each component,
  3. Spike sample result for each component,
  4. Percent recovery of each component,
  5. Relative percent difference between spike and spike duplicate of each component, and
  6. Analysis date and time.
- G. Results of dual column confirmation.
- H. Blank analysis summary.
- I. Holding time summary report, including extract holding times (where applicable).
- J. Detection limit summary report.