



DEPARTMENT OF THE NAVY

CRANE DIVISION  
NAVAL SURFACE WARFARE CENTER  
300 HIGHWAY 361  
CRANE, INDIANA 47522-5000

N00164.AR.000478  
NSWC CRANE  
5090.3a

IN REPLY REFER TO:

5090  
Ser 095/9195

13 OCT 1999

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

Dear Mr. Ramanauskas:

Please find in enclosure (1) the revised Risk Management Plan for the Ammunition Burning Ground, Old Rifle Range, and Demolition Range, submitted by Crane Division, Naval Surface Warfare Center (NAVSURFWARCENDIV Crane). This document was previously sent to you via email. NAVSURFWARCENDIV Crane also submits the required certification statement as enclosure (2).

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

Sincerely,

James M. Hunsicker  
Director, Environmental  
Protection Department  
By direction of the Commander

Encl:

- (1) Risk Management Plan
- (2) Certification Statement

Copy to:

ADMINISTRATIVE RECORD (w/2 copies)  
SOUTHNAVFACENCOM (Code 1864) (w/o encl)  
IDEM (Mike Sickels)  
TTNUS (Ralph Basinski)

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

  
SIGNATURE

ENV. PROTECTION DEPT. Mg.  
TITLE

10/13/99  
DATE

**RISK MANAGEMENT PLAN**

**FOR**

**AMMUNITION BURNING GROUND, OLD RIFLE RANGE, AND DEMOLITION RANGE**

**NAVAL SURFACE WARFARE CENTER**

**CRANE**

**SEPTEMBER 1999**

## **RISK MANAGEMENT PLAN FOR OPEN BURNING/OPEN DETONATION UNITS**

The Naval Surface Warfare Center (NSWC) Crane operates open burning/open detonation (OB/OD) treatment units for the demilitarization of waste explosives and propellants. These treatment units include the Ammunition Burning Ground (ABG), Old Rifle Range (ORR), and Demolition Range (DR). The waste munitions/explosives treated in these units are classified as hazardous waste due to the reactivity characteristic. The OB/OD treatment units are classified as hazardous waste treatment units and are currently operated under interim status. NSWC Crane has submitted a permit application for operation of ABG, ORR, and DR as permitted hazardous waste treatment units.

*OB/OD treatment units are classified as miscellaneous units and are subject to the environmental performance standards described in 40 CFR 264 Subpart X. Human Health and Ecological Risk Assessment have been conducted to assess the impacts of operation of the treatment units on human health and the environment. The Current Contamination Conditions Risk Assessment (CCCRA) assessed impacts from current contamination at the ABG, ORR, and DR on human health and ecological receptors. The RCRA Air Quality Assessment assessed ambient air concentrations of OB/OD treatment emissions. The Air Emissions Human Health Risk Assessment assessed the impacts of future operations of the ABG, ORR, and DR as permitted facilities at the capacity levels requested in the Part B permit application using the ambient air concentrations developed in the RCRA Air Quality Assessment.*

A risk management criterion for cumulative cancer risk (for each receptor population) in the range of  $1E-6$  to  $1E-4$  and a cumulative hazard index of up to 1 were used to identify potentially adverse effects on human health. Any risk greater than  $1E-4$  or hazard greater than 1 was considered to be a potentially adverse impact on human health.

Following is a discussion of potentially adverse human health impacts as identified in the Air Emission and Current Conditions Health Risk Assessments and the RCRA Air Quality Assessment. To control adverse health impacts associated with OB/OD operations, risk management techniques are proposed as follows:

### **Manganese Emissions from Demolition Range**

The Air Emissions Human Health Risk Assessment identified manganese emissions as a potential adverse human health impact. When considering the impacts of manganese it is important to recognize the highly conservative assumptions used in the risk assessment.

- First, manganese emissions are assumed to arise from the DR, as "vaporization" of the steel casings in the munitions. Total vaporization of the casings does not occur and residual metal pieces (large and small) can be readily observed throughout the soil matrix at the DR.
- Second, the air dispersion models used in this assessment to estimate the ambient air concentrations of all emissions did not take into account the reduction in concentration during the time the receptor individuals were indoors, resulting in an approximately seventy percent reduction in ambient concentrations.
- Third, the exposure assessment assumed a 'porch potato' receptor, i.e., the various receptor individuals were assumed to be outdoors at their respective receptor point 24 hours/day, 7 days/week for up to 70 years in the case of the Pandanaram Commune.
- Fourth, the reference concentration for manganese contains a safety factor of 1000, a highly conservative safety factor.
- Fifth, the air dispersion models used to predict contaminant concentrations at receptor locations do not consider plume depletion. This results in over-predictions of ambient air concentrations at receptors. These over-predictions can be an order of magnitude or greater.

#### **Risk Management Recommendation**

No risk management requirements are necessary. Assumptions in the Air Emission Health Risk Assessment resulted in a large over prediction of the actual manganese impacts that occur. Therefore, effects from manganese emissions on human health are considered to be less than significant when safety factors are considered.

#### **Off-Facility Residents Ingesting Ground Water**

The CCCRA identified ingestion of ground water containing chlorinated solvents and manganese to present significant risks and hazards to offsite receptors ingesting ground water contaminated by releases from the Ammunitions Burning Grounds (ABG). It was assumed that water from the alluvial aquifer was used as a drinking water source by off-site receptors. The assumed exposure point concentrations are contained in Table 4-16 (Attachment 1) of the CCCRA. The principal risk/hazard drivers were chlorinated solvents and manganese.

NSWC Crane has conducted two ground water monitoring events (Monitoring events No. 1 and 2) at the ABG. These monitoring events were conducted in October/November 1998 and February 1999. The wells monitored include two wells (B02 and B04) located in the alluvial aquifer at the NSWC boundary. Attachment 2 and 3 contain a summary of the results for all parameters detected at least once in each of the two monitoring events. These monitoring results show that chlorinated solvents are not found at detectable levels in samples obtained from the

alluvial aquifer in either monitoring event. Manganese and arsenic were detected although at much lower levels than those assumed in CCCRA/

Based on the results from Monitoring Events 1 and 2, the ABG is not the source of arsenic and manganese in the alluvial aquifer. The highest arsenic concentrations are found in the Beech Creek upgradient Well (03C17) indicating that the ABG is not the source of arsenic and manganese found in the alluvial aquifer. Arsenic is below detection levels for all spring and creek sampling points. The highest manganese concentrations are also found in the upgradient well (03C17). Manganese was not found in detectable concentrations in any of the spring samples for either monitoring round. Manganese was not detected in either surface water sample in the second round and found in one of two surface water sample in the first round samples. The high concentrations of manganese in the alluvial aquifer appear to be a result of dissolution of alluvial aquifer materials.

**Risk Management Recommendation**

No risk management requirements are necessary. The analytical results from ABG ground water Monitoring events No. 1 and 2 show that ABG treatment operations have not contaminated the alluvial aquifer.

**Ingestion of Ground Water by on-SWMU (ABG) Residents, Employees, and Visitors**

The CCCRA identified significant risks and hazards to future residents, employees, and visitors from the ingestion of contaminated ground water from the Beech Creek aquifer underlying the ABG and the Old Jeep Trail and from consumption of products from domestic animals raised at the Old Jeep Trail. Analytical results from the first two ABG Monitoring events show that presence of contaminants in ABG ground water, which were listed in the CCCRA as chemicals of concern.

**Risk Management Recommendation**

- 1) NSWC Crane is owned and controlled by the federal government. While under federal government ownership and control, ground water from the Beech Creek aquifer, underlying the ABG and Old Jeep Trail, will not be used as a drinking water source. In addition, the ABG will not be used for residents or raising domestic animals and, if transfer of property occurs, the federal government will place restrictions into the lease to prevent use of the underlying ground water as drinking water for residences or the raising of domestic animals.

- 2) The Navy will evaluate monitored natural attenuation with source control as a corrective action for existing contamination at the ABG.
- 3) The Navy will conduct a corrective measures study addressing existing contamination at the ABG. This study will determine if monitored natural attenuation with source control is adequate to address the existing contamination
- 4) The approved-Ground Water Monitoring Plan contains requirements for monitoring ground water, and spring and surface water expressions of ground water to determine if ABG ground water is exceeding the Ground Water Protection Standard at or beyond the Point of Compliance. The Navy will follow the procedures in the Monitoring Plan for developing and implementing any necessary corrective measures if the Ground Water Protection Standard is exceeded.
- 5) The Navy will develop a Work Plan for investigations at the Old Jeep Trail to determine the nature and extent of contamination. The approved-Quality Assurance Project Plan (QAPP) and approved-Field Sampling Plan will be modified as necessary to address investigations at the Old Jeep Trail.

**Ingestion of Ground Water by on-SWMU (ORR) Residents, Employees, and Visitors**

The CCCRA identified significant risks and hazards to future residents, employees, and visitors from the ingestion of contaminated ground water from the ORR and to future residents from consumption of products from domestic animals raised at the ORR.

**Risk Management Recommendation**

- 1) NSWC Crane is owned and controlled by the federal government. While under federal government ownership and control, ground water underlying the Old Rifle Range (ORR) will not be used as a drinking water source. The ORR will not be used for residences or for raising domestic animals. If any transfers of the ORR property occur the federal government will place restrictions into the lease to prevent use of the ground water for drinking water or for residences or raising of domestic animals.
- 2) The approved-Ground Water Monitoring Plan contains requirements for monitoring of ORR ground water at the Point of Compliance and comparisons to the Ground Water Protection Standard. If the Ground Water Protection Standard is exceeded, the Navy will implement procedures described in the Monitoring Plan for development and

implementation of corrective measures, including a corrective measure study for the ingestion of groundwater. In addition, groundwater will not be used for drinking water while under government control or if the property is transferred.

#### **Ingestion of Ground Water by on-SWMU (DR) Residents, Employees, and Visitors**

The CCCRA identified significant hazards to future residents, employees, and visitors from the ingestion of DR ground water contaminated with metals. Corrective measures studies will be undertaken including the ingestion of groundwater. Risks were also identified to future residents consuming products contaminated with metals and explosives from domestic animals raised on the DR. Contaminants are not present in monitoring wells located at the ground water Point of Compliance. The approved Groundwater Monitoring Plan contains requirements for determining the need and nature of any corrective measures if the groundwater is found to be contaminated at the point of compliance.

#### **Risk Management Recommendation**

- 1) NSWCC Crane is owned and controlled by the federal government. While under federal government ownership and control, ground water underlying the DR will not be used as a drinking water source, nor will the DR be used for residences or for raising domestic animals. If any transfers of the Dr Property occur the federal government will place restrictions into the lease to prevent use of the ground water for drinking water or for residences or raising of domestic animals.

#### **Ambient Air Lead Concentrations (DR)**

The RCRA Air Quality Assessment identified exceedences of the IDEM 8-hour ambient air standards for lead. These exceedences were primarily attributable to lead emissions from the DR. When considering the impacts of lead it is important to recognize the highly conservative assumptions used in the risk assessment.

- First, lead emissions from the DR, include lead from "vaporization" of lead in metallic components of the munitions. Total vaporization of the metallic components does not occur. Residual metal pieces (large and small) can be readily observed throughout the soil matrix at the DR.
- Second, the air dispersion models used in this assessment to estimate the ambient air concentrations of all emissions did not take into account the reduction in exposure during the time the receptor individuals were indoors, resulting in an approximately seventy percent reduction in exposure.

- Third, the exposure assessment assumed a 'porch potato' receptor, i.e., the various receptor individuals were assumed to be outdoors at their respective receptor point throughout the exposure period.
- Fourth, the air dispersion models used to predict ambient air contaminant concentrations at receptor locations do not consider plume depletion. This results in over-predictions of ambient air contaminant concentrations. These over-predictions can be an order of magnitude or greater.

#### **Risk Management Recommendation**

- 1) The Navy will incorporate reduction in the treatment of lead-containing wastes into the waste minimization program.

**ATTACHMENT 1**

**TABLE 4-16**

**FROM**

**CURRENT CONTAMINATION CONDITIONS RISK ASSESSMENT**

**SWMU #03/10 (AMMUNITION BURNING GROUND)**

**SWMU #07/09 (OLD RIFLE RANGE)**

**SWMU # 06/09 (DEMOLITION RANGE)**

**NAVSURFWARCENDIV**

**CRANE, INDIANA**

**FEBRUARY 1999**

TABLE 4-16

EXPOSURE POINT CONCENTRATIONS OF CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER (ALLUVIUM) - ABG  
 Page 1 of 2

Chemical	Frequency of Detection <sup>A</sup>	Range of Detected Values (mg/L)	Range of Reporting Limits (mg/L)	Arithmetic Mean Concentration (mg/L)	95% UCL Concentration (mg/L)	Exposure Point Concentration <sup>B</sup> (mg/L)
1,1-Dichloroethylene	1/2	0.007	0.005	0.00475	0.019	0.007
1,1,2-Trichlorethane	1/2	0.0545	0.005	0.0285	0.193	0.0545
1,1,2,2-Tetrachlorethane	1/2	0.505	0.005	0.254	1.84	0.505
1,2-Dichloroethylene (total)	1/2	1.15	0.005	0.576	4.2	1.15
4-Nitrophenol	1/2	0.001	0.05	0.013	0.089	0.001
Aluminum	3/4	0.715 - 1.95	0.20	1.16	2.23	1.95
Arsenic	4/4	0.0023 - 0.011	NA	0.006	0.04	0.011
Barium	3/4	0.059 - 0.072	0.1	0.0607	0.075	0.072
Bis(2-ethylhexyl)phthalate	1/2	0.0012	0.01	0.003	0.015	0.0012
Cadmium	1/4	0.0099	0.001 - 0.002	0.0026	2.23	0.0099
Chloroethane	1/2	0.007	0.01	0.006	0.01	0.007
Chloroform	1/2	0.001	0.005	0.002	0.006	0.001
Chromium	2/4	0.0062 - 0.0214	0.005	0.011	0.0213	0.0213
Cobalt	1/4	0.004	0.005 - 0.04	0.007	0.34	0.004
Copper	3/4	0.0073 - 0.0152	0.03	0.0125	0.017	0.0152
Disulfoton	1/1	0.0012	NA	NA	NA	0.0012

**TABLE 4-16 (Continued)**  
**EXPOSURE POINT CONCENTRATIONS OF CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER (ALLUVIUM) - ABG**  
 Page 2 of 2

Chemical	Frequency of Detection <sup>A</sup>	Range of Detected Values (mg/L)	Range of Reporting Limits (mg/L)	Arithmetic Mean Concentration (mg/L)	95% UCL Concentration (mg/L)	Exposure Point Concentration <sup>B</sup> (mg/L)
Lead	3/4	0.0051 - 0.0076	0.01	0.0057	0.0076	0.0076
Manganese	4/4	0.562 - 5.81	NA	2.27	126	5.81
Mercury	1/4	0.00051	0.0002 - 0.007	0.00027	0.00051	0.00051
Methylene chloride	1/2	0.0012	0.016	0.0046	0.026	0.0012
Nickel	1/4	0.0239	0.02 - 0.04	0.016	0.0243	0.0239
Nitrobenzene	1/4	0.0006	0.001 - 0.002	0.00073	0.001	0.0006
Silver	1/4	0.0018	0.005 - 0.03	0.005	0.234	0.0018
Tetrachloroethylene	1/2	0.009	0.005	0.00575	0.026	0.009
Trichloroethylene	1/2	2.3	0.005	1.2	8.4	2.3
Vanadium	2/4	0.0051 - 0.0068	0.005 - 0.04	0.0086	0.0178	0.0068
Vinyl chloride	1/2	0.018	0.01	0.012	0.05	0.018
Xylene	1/2	0.0029	0.01	0.004	0.01	0.0029
Zinc	2/4	0.022 - 0.0242	0.024 - 0.027	0.018	0.034	0.0242

<sup>A</sup> Number of samples in which the analyte was detected/total number of samples analyzed.

<sup>B</sup> The 95% UCL (upper confidence limit of the mean) or the maximum detected value, whichever is lower (U.S. EPA, 1989).

NA = Not applicable.

**ATTACHMENT 2**

**SUMMARY OF PARAMETERS DETECTED AT LEAST ONCE**

**MONITORING EVENT NO. 1 – AMMUNITION BURNING GROUNDS**

**OCTOBER/NOVEMBER 1998**

TABLE 2  
SUMMARY OF PARAMETERS DETECTED AT LEAST ONCE  
MONITORING EVENT NO. 1  
AMMUNITION BURNING GROUNDS  
NAVAL STATION WARFARE CENTER, CRANE

Location Aquifer Sample Date	B02 ALLUVIUM 11/05/98	B02 ALLUVIUM 11/05/98	B04 ALLUVIUM 11/09/98	C02P2 BEECH CREEK 11/09/98	C03 BEAVER BEND 11/06/98	C04 BEECH CREEK 11/11/98	C07 BEECH CREEK 11/11/98	C08P2 BEECH CREEK 11/10/98	C09P2 BEECH CREEK 11/08/98	C09P2 BEECH CREEK 11/08/98	C10 BEECH CREEK 11/08/98	C10 BEECH CREEK 11/08/98	C11 BEECH CREEK 11/06/98	C03C12 BEECH CREEK 11/08/98	C15 BEECH CREEK 11/10/98	C17 BEECH CREEK 11/09/98	C20 BEECH CREEK 11/10/98	C25 BEECH CREEK 11/07/98	C26 BEECH CREEK 11/10/98	C27 BEECH CREEK 11/09/98	C30 BEECH CREEK 11/11/98
Volatile Organics (ug/L)																					
CIS-1,2-DICHLOROETHENE	0.6 U	0.5 U	0.5 U	1.7	0.5 U	0.5 U	0.5 U	12	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	18	0.7 J	0.5 U	0.5 U	59	0.5 U	0.5 U	0.5 U
TRANS-1,2-DICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	8.6	0.5 U	0.5 U	0.5 U
TRICHLOROETHENE	0.5 U	0.5 U	0.5 U	23	0.5 U	0.5 U	4.1	59	150 J	150	59	66	1500	21	0.5 U	0.5 U	3400	0.5 U	81	49	0.5 U
Dissolved Gases (ug/L)																					
ETHANE	0.062 U	0.076 U	0.033 U		0.140 J	0.024 U					0.053 U	0.037 U	0.403 J	0.037 U					0.132 J		
ETHENE	0.005 U	0.005 U	0.009		0.005 U	0.017					0.005 U	0.005 U	0.005 U	0.005 U					0.005 U		
METHANE	7.723 J	6.77 J	2.667 U		13.897 J	37.82 J					1.833 U	1.465 U	2220 J	1.446 U					53.68 J		
Energetics (ug/L)																					
2,3,5-TRINITROBENZENE	0.53 U	1.4 U	0.42 U	0.48 U	0.78 U	0.71 U	0.65 U	1.2 U	1.2 U	0.58 U	1.4 U	0.49 U	1.2 U	0.68 U	0.75 U	0.95 U	6.5 J	1.4 U	0.65 U	0.92 U	1.4 U
2,4,6-TRINITROTOLUENE	0.53 U	1.4 U	0.42 U	0.48 U	0.78 U	0.71 U	0.65 U	1.2 U	1.2 U	0.58 U	1.4 U	0.49 U	1.2 U	0.68 U	0.75 U	0.95 U	0.54	1.4 U	0.65 U	0.92 U	1.4 U
2,6-DINITROTOLUENE	0.53 U	1.4 U	0.42 U	0.48 U	0.78 U	0.71 U	0.65 U	1.2 U	1.2 U	0.58 U	1.4 U	0.49 U	1.2 U	0.68 U	0.75 U	0.95 U	0.39 U	1.4 U	0.65 U	0.92 U	1.4 U
2-AMINO-4,6-DINITROTOLUENE	0.53 U	1.4 U	0.42 U	0.48 U	0.78 U	0.71 U	0.65 U	2.1	1.2 U	0.58 U	1.4 U	0.49 U	1.2 U	0.68 U	0.75 U	0.95 U	12	1.4 U	0.65 U	0.92 U	1.4 U
4-AMINO-2,6-DINITROTOLUENE	0.53 U	1.4 U	0.42 U	0.48 U	0.78 U	0.71 U	0.65 U	3.7 J	1.2 U	0.58 U	1.4 U	0.49 U	1.2 U	0.68 U	0.75 U	0.95 U	17	1.4 U	0.65 U	0.92 U	1.4 U
HMX	0.53 U	1.4 U	0.42 U	28	0.78 U	0.71 U	7.3	33	3.8 J	3.8 J	6.3	6.5	4.6	35	0.75 U	0.95 U	27	1.4 U	0.65 U	0.92 U	1.4 U
MX	0.53 U	1.4 U	0.42 U		0.78 U	0.71 U					2.8	2.5	1.2 U	0.68 U					1.4 U		
RDX	0.53 U	1.4 U	0.42 U	21	0.78 U	0.71 U	36	100	170	140	130	140	27	32	0.75 U	0.95 U	190	1.4 U	0.7	0.92 U	1.4 U
TNX	0.53 U	1.4 U	0.42 U		0.78 U	0.71 U					1.4 U	0.57	1.2 U	0.68 U					1.4 U		
Total Metals (ug/L)																					
ARSENIC	9.8	9.4	11.1 U	11.1 U	12	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	1.2	2.4	11.1 U	11.1 U	11.1 U	11.1 U
BARIUM	87.4	85.8	96.2	40.3	41.6	29	69.6	15.9	14.3	42.2	42	24.7	90.7	28.4	12.8	30.6	16.8	39.4	34	65.1	
COPPER	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U
IRON	12400 J	12050 J	2950 J	148	169 J	531	107	129	477 J	419 J	207 J	208 J	272 J	120 J	528	1810 J	112	263 J	110	145	184
LEAD	1.1 U	1.1 U	1.1 U	1.1 U	1.2 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U
MANGANESE	1340	1270	1070	16.7 U	16.7 U	334	37.8	16.7 U	72.3	65.8	16.7 U	16.7 U	16.7 U	16.7 U	34.7	132	16.7 U	22.0	43.8	16.7 U	48.7
SELENIUM	1.1 U	1.1 U	1.1 U	2.3	1.1 U	3.6	2	1.3	1.2	1.4	2	1.8	2.2	1.1 U	1.1	1.1 U	1.2	1.1 U	1.1 U	1.1 U	1.1 U
ZINC	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	20.8	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U
Dissolved Metals (ug/L)																					
ARSENIC FILTERED	10.2	10	2.6	11.1 U	11.1 U		11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	1.2	2.2	11.1 U	11.1 U	11.1 U	11.1 U
BARIUM FILTERED	86.9	80.6	72.2	94.8	42.1		29.1	62.9	13.6	13.4	42.2	43.9	24.3	90.9	27.4	12.9	30.9	16.4	38.6	32.9	64.6
CALCIUM FILTERED	44700	43700	56000	119000	1200		102000	123000	76700	84100	93600	93600	213000	102000	104000	201000	88400	98500	58400	69400	
COPPER FILTERED	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U		5.4	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U
MAGNESIUM FILTERED	6080	5960	10400	17900	1110 U		48700	41900	15200	15200	12500	12500	20500	31700	59800	7210	39600	54500	3420	36800	
MANGANESE FILTERED	1390	1350	1120	16.7 U	16.7 U		34.3	16.7 U	16.7 U	16.7 U	16.7 U	16.7 U	16.7 U	16.7 U	32.7	137	16.7 U	23.2	54.8	16.7 U	55.3
POTASSIUM FILTERED	1120	1120	1110 U	2660	1110 U		1740	10400	1200	1260	1110 U	1110 U	2640	1960	1630	3140	1950	2550	1900	1190	3090
SELENIUM FILTERED	1.1 U	1.1 U	1.1 U	2.1	1.1 U		1.9	1.3	1.1 U	1.1 U	2	1.6	2.6	1.1 U	1.1 U	1.1 U	1.2	1.1 U	1.1 U	1.2	1.1 U
SODIUM FILTERED	10200	9920	4480	33000	240000		23200	16900	4730	4870	7210	7680	110000	12300	18300	119000	12700	69300	17400	7210	68200
Miscellaneous (mg/L)																					
ALKALINITY AS CaCO3	130 J	120 J	150 J	220 J	370 J	350 J	350 J	340 J	190 J	190 J	210 J	200 J	320 J	190 J	280 J	420 J	230 J	360 J	360 J	150 J	300 J
BICARBONATE ALKALINITY	130 J	120 J	150 J	220 J	270 J	350 J	350 J	340 J	190 J	190 J	210 J	200 J	320 J	190 J	280 J	420 J	230 J	360 J	360 J	150 J	300 J
CARBONATE ALKALINITY	2.0 U	2.0 U	2.0 U	2.0 U	100	2 U	2 U	2 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U	2.0 U
CHLORIDE	4	4	3		2	7					9	9	43	29				2			
CONDUCTIVITY (MS/CM)	0.417		0.446	0.765	1.05	1.598	0.874	1.024	0.469		0.642		2.22	0.85	0.862	2.081	0.626	1.229	0.76	0.373	0.73
CYANIDE	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
DISSOLVED OXYGEN	0.45		1.34	6.55	1.34	10.68	4.43	3.15	4.73		3.76		7.75	10.12	2.02	2	2.46	1.09	2.92	13.11	1.06
NITRATE AS NITROGEN	0.20 U	0.20 U	0.20 U	3.4	0.20 U	0.2 U	0.8	2.7 J	4.7		2.1	2.1	13	1.5	0.2 U	0.20 U	2.1 J	0.20 U	0.2 U	0.2 U	0.2 U
NITRITE AS NITROGEN	0.10 U	0.10 U	0.10 U		0.10 U	0.1 U					0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U	0.10 U
OXIDATION REDUCTION POTENTIAL (MV)	-146		-74.6	169.4	-45.2	-30.3	117.2	145.9	245.1		141.9		-49.6	115	12.5	-7.7	159.8	-88	151.6	140.4	-115.1
PH (pH)	7.23		7.17	6.89	7.17	7.27	7.15	7.10	6.80		6.45		7.19	7.14	7.12	6.98	7.18	7.15	7.33	7.66	8.43
SULFATE	27	26	23	58 J	400	770 J	78 J	110 J	43	43	56	55	740	56	140 J	800	91 J	220	69 J	8 J	130 J
TEMPERATURE (C)	15		14	13.89	13.7	11.3	11.2	12.4	13.4		14.11		12.47	13	13.8	12.1	13.4	11.6	15.11	12.2	12.22
TOTAL ORGANIC CARBON	1.0 U	1.0 U	1.0 U	1.6	1.0 U	1.6	1.0 U	3.7	1.0 U	1.0 U	1.0 U	1.0 U	3.2 J	1.0 U	1.0 U	1.0 U	1.5	1.0 U	3.3	1.0 U	1.0 U
TOTAL ORGANIC HALOGENS	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.05	0.05	0.11	0.09	0.06	0.06	1.1	0.02 U	0.02 U	0.02 U	1.5	0.02 U	0.02 U	0.02 U	0.02 U
TOTAL PHOSPHORUS AS P	0.02 U	0.02 U	0.01 U	0.04	0.05 U	0.01 U	0.01 U	0.01 U	0.05 J	0.05 U	0.02 U	0.02 U	0.01 U	0.02 U	0.01 U	0.01 U	0.01	0.01 U	0.01	0.01	0.01
TOTAL PHOSPHORUS AS P FILTERED	0.02 U	0.02 U	0.01 U	0.04	0.05 U	0.01 U	0.01 U	0.01 U	0.03 U	0.03 U	0.02 U	0.02 U	0.01 U	0.02 U	0.01 U	0.01 U	0.01	0.01 U	0.01	0.01	0.01
TURBIDITY (NTU)	0.9		0	3	5	1	1	0	17		2		0	0	2	0	1	2	0	0	2

TABLE 2  
SUMMARY OF PARAMETERS DETECTED AT LEAST ONCE  
MONITORING EVENT NO. 1  
AMMUNITION BURNING GROUNDS  
NAVAL STATION WARFARE CENTER, CRANE

CREEK	CREEK	SPRING A	SPRING C
11/05/98	11/05/98	11/05/98	11/05/98
0.8 U	0.8 U	0.8 U	0.8 U
0.8 U	0.8 U	0.8 U	0.8 U
0.8 U	0.8 U	0.8 U	0.8 U
0.018 U	0.005 U	0.005 U	0.005 U
0.005 U	0.005 U	0.005 U	0.005 U
9.4 J	1.074 L	1.178 U	0.687 U
0.71 U	0.90 U	0.86 U	0.79 U
0.71 U	0.90 U	0.86 U	0.79 U
0.71 U	0.90 U	0.86 U	0.79 U
0.71 U	0.90 U	1.8	0.79 U
0.71 U	1.2 J	3.4 J	0.79 U
8.1	9.3	26	0.79 U
0.71 U	0.90 U	0.86 U	0.79 U
28	20	63	1.4
0.71 U	0.90 U	0.86 U	0.79 U
1.1 U	1.1 U	1.1 U	1.1 U
158	131	125	62.2
2.2 U	2.2 U	3.7 J	2.2 U
192 J	106 J	148 J	93.0 J
1.1 UF	1.1 UF	3.8 J	1.1 UF
102	16.7 U	16.7 U	16.7 U
1.1 U	1.1 U	1.3	1.1 U
1.1 U	1.1 U	11.9	11.1 U
1.1 U	1.1 U	1.1 U	1.1 U
145	130	122	64.2
53900	57800	64500	60100
2.2 U	2.2 U	2.2 U	2.2 U
11300	11100	15000	13600
110	16.7 U	16.7 U	16.7 U
2400	3010	5070	1130
1.1 U	1.1 U	1.1	1.1 U
7470	7110	10500	7490
130 J	130 J	140 J	150 J
130 J	130 J	140 J	150 J
2.0 U	2.0 U	2.0 U	2.0 U
8	9	14	5
0.495	0.465	0.531	0.475
0.01 U	0.02	0.05	0.01 U
9.75	10.03	10.38	10.53
0.2	0.9	2.3	0.5
0.10 U	0.2	0.3	0.10 U
37.9	155.9	1412	191.8
7.72	7.73	8.36	7.95
46	43	59	56
7.12	9.31	10.86	11.38
1.4 J	1.8 J	4.1 J	1.0 U
0.02 U	0.02 U	0.02 U	0.02 U
0.01 U	0.02 U	0.05 U	0.02 U
3.01 U	0.02 U	0.04 U	0.02 U
2.4	5.9	10.3	1.8

**ATTACHMENT 3**

**SUMMARY OF PARAMETERS DETECTED AT LEAST ONCE**

**MONITORING EVENT NO. 2 – AMMUNITION BURNING GROUNDS**

**FEBRUARY 1999**

TABLE 2  
SUMMARY OF PARAMETERS DETECTED AT LEAST ONCE  
MONITORING EVENT NO. 2  
AMMUNITION BURNING GROUNDS  
NAVAL SURFACE WARFARE CENTER, CRANE

location	03B02	03B04	03C02P2	03C03	03C04	03C07	03C08P2	03C09P2	03C10	03C11	03C11	03C12	03C15	03C17	03C20	03C25	03C26	03C27	03C27	03C30	CREEK	CREEK	CREEK	SPRING A	SPRING C	
aquifer	ALLUVIUM	ALLUVIUM	BEECH CREEK	BEAVER BEND	BEECH CREEK	CREEK	CREEK	CREEK	SPRING A	SPRING C																
matrix	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	SW	SW	SW	SW	SW	
sample	AB021A99	AB041A99	AC02P21A99	AC031A99	AC041A99	AC071A99	AC08P21A99	AC09P21A99	AC101A99	AC111A99	AC111A99-D	AC121A99	AC151A99	AC171A99	AC201A99	AC251A99	AC261A99	AC271A99	AC271A99-D	AC301A99	ACRA1A99	ACRB1A99	ACRB1A99-D	ASPA1A99	ASPCA1A99	
sample	AB021A99	AB041A99	AC02P21A99	AC031A99	AC041A99	AC071A99	AC08P21A99	AC09P21A99	AC101A99	AC111A99	FD02259901	AC121A99	AC151A99	AC171A99	AC201A99	AC251A99	AC261A99	AC271A99	FD03029901	AC301A99	ACRA1A99	ACRB1A99	FD02289901	ASPA1A99	ASPCA1A99	
sacode	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	DUP	DUP	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL	DUP	DUP	NORMAL	DUP	DUP	NORMAL	NORMAL		
sample, date	03/10/99	02/23/99	02/26/99	02/27/99	02/27/99	02/26/99	03/12/99	03/01/99	02/25/99	02/25/99	02/25/99	02/25/99	03/01/99	03/08/99	03/11/99	02/24/99	03/02/99	03/02/99	03/02/99	03/08/99	02/28/99	02/28/99	02/28/99	02/28/99	02/28/99	
duplicate											AC111A99							AC271A99			ACRB1A99					
<b>Volatiles Organics (ug/L)</b>																										
1,2-DICHLOROETHANE	0.5 U	0.5 U		0.5 U	0.5 U				29	0.5 U	0.5 U	0.5 U				0.5 U					0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
CARBON TETRACHLORIDE	0.5 U	0.5 U		0.5 U	0.5 U				1.6	0.5 U	0.5 U	0.5 U				0.5 U					0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
CHLOROFORM	0.5 U	0.5 U		0.5 U	0.5 U				2.2	2	2	0.5 U				0.5 U					0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
CIS-1,2-DICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	14	0.5 U	0.5 U	13	13	0.7	0.5 U	0.5 U		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U					
METHYLENE CHLORIDE	0.5 U	0.5 U		0.5 U	0.5 U					0.5 U	0.5 U	0.5 U				0.5 U					0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	
TRANS-1,2-DICHLOROETHENE	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	7.3	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U					
TRICHLOROETHENE	0.5 U	0.5 U	7.7	0.5 U	0.5 U	4.7	71	160	63	2100	2109	22	0.5 U	0.5 U	3703	0.5 U	4.2	4	8.9	0.5 U	0.5 U	0.5 U	0.6	0.5 U		
<b>Dissolved Gases (ug/L)</b>																										
ETHANE	0.051	1.454		0.195	0.059				0.274	0.372	0.273	0.153				0.592					0.147	0.147	0.192	0.112	0.119	
ETHENE	0.045	0.232		0.042	0.027				0.054	0.057	0.039	0.03				0.059					0.033	0.034	0.039	0.027	0.026	
METHANE	8.426	13.569		13.375	6.754				1.788	800	660	0.912				55.04					0.764	0.901	1.557	0.501	0.536	
<b>Energetics (ug/L)</b>																										
2,3,5-TRINITROBENZENE	0.58 U	0.94 U	0.49 U	1.0 U	0.46 U	1.2 U	1.2 U	0.44 U	1.5 U	1.9 U	1.1 U	0.74 U	0.49 U	1.2 U	6.1	1.2 U	1.4 U	1.3 U	0.55 U	0.55 U	0.70 U	0.65 U	0.64 U	0.29 U	1.6 U	
2,4,6-TRINITROTOLUENE	0.58 U	0.94 U	0.49 U	1.0 U	0.46 U	1.2 U	1.2 U	0.44 U	1.5 U	1.9 U	1.1 U	0.74 U	0.49 U	1.2 U	0.56 U	1.2 U	1.4 U	1.3 U	0.55 U	0.55 U	0.70 U	0.65 U	0.64 U	0.29 U	1.6 U	
2,6-DINITROTOLUENE	0.58 U	0.94 U	0.49 U	1.0 U	0.46 U	1.2 U	1.2 U	0.70 U	1.5 U	1.9 U	1.1 U	0.74 U	0.49 U	1.2 U	0.56 U	1.2 U	1.4 U	1.3 U	0.55 U	0.55 U	0.70 U	0.65 U	0.64 U	0.29 U	1.6 U	
2-AMINO-4,6-DINITROTOLUENE	0.58 U	0.94 U	0.49 U	1.0 U	0.46 U	1.2 U	1.2 U	2.6	0.44 U	1.5 U	1.9 U	0.74 U	0.49 U	1.2 U	12.0	1.2 U	1.4 U	1.3 U	0.55 U	0.55 U	0.70 U	0.65 U	0.64 U	0.29 U	1.6 U	
4-AMINO-2,6-DINITROTOLUENE	0.58 U	0.94 U	0.49 U	1.0 U	0.46 U	1.2 U	1.2 U	4.5	0.44 U	1.5 U	1.9 U	0.74 U	0.49 U	1.2 U	18.0	1.2 U	1.4 U	1.3 U	0.55 U	0.55 U	0.70 U	0.65 U	0.64 U	0.29 U	1.6 U	
HMX	0.58 U	0.94 U	5.1	1.0 U	0.46 U	4.4	31	2.8	6.7	5.5	5.6	27	0.49 U	1.2 U	25	1.2 U	1.4 U	1.3 U	0.55 U	0.55 U	2.6	2.0	2.0	4.0	1.6 U	
MX	0.58 U	0.94 U		1.0 U	0.46 U				3.1	1.0 U	1.1 U	0.74 U				1.2 U	1.4 U	1.3 U	0.55 U	0.55 U	0.70 U	0.65 U	0.64 U	0.29 U	1.6 U	
RDX	0.58 U	0.94 U	2.9	1.0 U	0.46 U	23	119	130	140	34	34	14	0.49 U	1.2 U	160	1.2 U	1.4 U	1.3 U	0.55 U	0.55 U	1.6	1.0	0.93	1.5	1.7	
<b>Total Metals (ug/L)</b>																										
ARSENIC	6.7	4.1	1.0 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U																	
BARIUM	76.1	77.4	61.2	38.3	31.4	29.6	70.2	15.4	42.4	22.9	22.0	88.7	23.1	11.0	29.7	15.8	37.4	23.1	34.3	32.3	61.1	37.1	35.9	34.2	42.0	27.6
COPPER	2.2 U	2.2 U	2.2 U	2.8	2.2 U	2.2 U	18.2	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U	2.2 U												
IRON	13500	6160		111 U	134				121	111 U	111 U	111 U	111 U	111 U	111 U	111 U										
LEAD	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	3.1	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U													
MANGANESE	1430	1650	16.7 U	16.7 U	76.3	16.7 U	16.7 U	59.6	16.7 U	16.7 U	16.7 U	16.7 U	36.2	11.1	16.7 U	24.1	40.0	16.7 U	16.7 U	30.3	16.7 U	16.7 U	16.7 U	16.7 U	16.7 U	
NICKEL	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	
SELENIUM	1.1 U	1.1 U	1.1 U	1.1 U	2.1	1.9	2.6	2.1	3.2	3.7	4.0	1.2	1.9	1.6	1.3	1.1 U	1.3	1.1	1.6	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	
ZINC	11.1 U	58.8 U	11.1 U	44.2 U	11.1 U	11.1 U	11.1 U	11.1 U	44.8 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U												
<b>Dissolved Metals (ug/L)</b>																										
ARSENIC FILTERED	6.0	3.6	1.1 U	1.1 U	1.5	1.1 U	2.1	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U	1.1 U													
BARIUM FILTERED	75.2	95.9	71.6	47.8	49	41	63.1	13.4	47.7	26.2	26.8	105	22.9	11.0	29.9	20.8	36.9	23.1	34.3	32.3	61.1	37.1	35.9	34.2	42.0	
CALCIUM FILTERED	44100	25100	36600	1140	149000	100000	112000	81300	91300	233000	234000	98600	104000	98700	201000	59600	98700	59600	201000	105000	71000	11500	11500	11700	13500	
COPPER FILTERED	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	3.3 U	
MAGNESIUM FILTERED	6210	3750	8340	1110 U	199000	48500	39700	15700	11900	139000	129000	8130	45100	199000	29900	60700	53100	3280	3150	35700	2710	2730	2740	3220	2470	
MANGANESE FILTERED	1420	1660	16.7 U	16.7 U	665	16.7 U	16.7 U	16.7 U	16.7 U	35.1	110	16.7 U	24.7	39.9	16.7 U	16.7 U	39.4	16.7 U	16.7 U	39.4	16.7 U	16.7 U	16.7 U	16.7 U	16.7 U	
POTASSIUM FILTERED	1130	1250	2150	1110 U	3690	5160	30800	1290	1110 U	3180	3190	2050	1990	3220	1990	2650	2110	1220	1220	2790	1220	1130	1220	1400	1110	
SELENIUM FILTERED	1.1 U	1.1	1.6	1.1 U	2.2	2.3	2.2	2.2	3.2	3.9	4.2	1.4	1.9	1.9	1.4	1.1	1.3	2	1.1 U	1.1 U	1.2	1.1 U	1.1 U	1.1 U	1.1 U	
SODIUM FILTERED	5928	5470	21350	219000	63900	23900	19700	4790	7190	94500	92300	13400	26900	115000	12000	63800	16800	5980	5800	68000	1780	1730	1750	2240	1530	
ZINC FILTERED	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	11.1 U	
<b>Miscellaneous (mg/L)</b>																										
ALKALINITY (MG/L)	148.8	78.4	80	356	365	346	323	195	200	290	0 NS	216	266	369	246	180	322	156	143	408	24.1	32.8	27.2	26.3	20.4	
BICARBONATE ALKALINITY (MG/L)	148																									