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NSWC CRANE
5090.3a

DEPARTMENT OF THE NAVY
CRANE DIVISION
NAVAL SURFACE WARFARE CENTER
300 HIGHWAY 361
CRANE, INDIANA 47522-5000

IN REPLY REFER TO:

5090
Ser 095/9185

20 SEP 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:

Crane Division, Naval Surface Warfare Center (NAVSURFWARCENDIV Crane) submits two copies of the revised pages for the Quality Assurance Project Plan and the Ground Water Monitoring Plan as enclosures (1) and (2), respectively. The documents are for ground water monitoring at the Ammunition Burning Grounds, Demolition Range, and Old Rifle Range. The changes were made in response to comments received in the Internal Draft (ID) Subpart X permit. Additionally, Tetra Tech NUS will be forwarding responses to the U.S. EPA's comments on the Field Sampling Plan, and resulting change pages. These documents are also in response to the comments in the ID Subpart X permit, plus comments in the U.S. EPA letter to NAVSURFWARCENDIV Crane, dated August 25, 1999. Enclosure (3) is the required Certification Statement.

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) Change Pages for the Quality Assurance Project Plan
(2) Change Pages for the Ground Water Monitoring Plan
(3) Certification Statement

Copy to:
ADMINISTRATIVE RECORD (w/2 copies)
SOUTHNAVFACENGCOM (Code 1829) (w/o encl)
IDEM (Mike Sickels)
TtNUS (Ralph Basinski) (w/o encl)

Change Pages
for the
• Quality Assurance Project Plan •

Ammunition Burning Grounds
Demolition Range
Old Rifle Range

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

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

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

1.5 SAMPLE NETWORK DESIGN AND RATIONALE

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

1.5.1 Sample Network by Task and Matrix

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

1.5.2 Site Maps of Sampling Locations

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

1.5.3 Rationale of Selected Sampling Locations

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

1.5.4 Sample Network Summary Table

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

1.6 PROJECT SCHEDULE

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

1.6.1 Anticipated Date of Project Mobilization

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

1.6.2 Task Bar Chart and Associated Timeframes

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

Change Pages
for the
• Ground Water Monitoring Plan •

Ammunition Burning Grounds
Demolition Range
Old Rifle Range

GROUND WATER MONITORING PLAN
FOR THE
AMMUNITION BURNING GROUNDS,
OLD RIFLE RANGE, AND DEMOLITION RANGE

NAVAL SURFACE WARFARE CENTER, CRANE DIVISION
CRANE, INDIANA

REVISION 2
SEPTEMBER 1999

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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

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

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

_____ Date_____
RALPH R. BASINSKI, Q.E.P.
TASK ORDER MANAGER
TETRA TECH NUS, INC.

_____ Date_____
DEBBIE WROBLEWSKI
PROGRAM MANAGER
TETRA TECH NUS, INC.

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PAUL V. FRANK
QUALITY ASSURANCE MANAGER
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_____ Date_____
JIM HUNSIKER
ENVIRONMENTAL DEPARTMENT MANAGER
NSWC CRANE

_____ Date_____
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PERMITTING PROJECT MANAGER
U.S. EPA REGION 5

_____ Date_____
KARYL SCHMIDT
HAZARDOUS WASTE GEOLOGIST
INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

_____ Date_____
TOM BRENT
PERMIT PROJECT MANGER
NSWC CRANE

_____ Date_____
E.P. JOHNS
ENGINEER IN CHARGE U.S. NAVY
NAVAL FACILITIES ENGINEERING COMMAND

1.0 GROUND WATER MONITORING [40 CFR 264 SUBPART F]

This Ground Water Monitoring Plan (GWMP) for the Naval Surface Warfare Center Crane (NSWC Crane), Indiana, was prepared for the U.S. Department of the Navy (Navy) by Tetra Tech NUS, Inc. (TtNUS) under the Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) contract, Contract Number N624467-94-D-0888, Contract Task Order (CTO) 038.

This GWMP outlines the overall scope of the ground water monitoring programs to be conducted in accordance with the Resource Conservation and Recovery Act (RCRA) permit to be issued by the United States Environmental Protection Agency (U.S. EPA) Region 5 to NSWC Crane, located in Crane, Indiana. The RCRA permit contains ground water monitoring requirements for three operating units used for the open burning and open detonation of munitions/explosives at NSWC Crane: the Ammunition Burning Grounds (ABG), the Old Rifle Range (ORR), and the Demolition Range (DR). This GWMP was developed in accordance with the requirements for RCRA ground water monitoring in 40 Code of Federal Regulations (CFR) 264 Subpart F and U.S. EPA technical guidance (U.S. EPA, 1986a). Compliance with 40 CFR Subpart F also results in compliance with Indiana Department of Environmental Management (IDEM) regulations. Groundwater monitoring will be conducted in compliance with the approved Field Sampling Plan (FSP) and the approved Quality Assurance Project Plan (QAPP).

1.1 GROUND WATER MONITORING OBJECTIVES

The primary ground water monitoring objectives for each of the three units were developed to meet the regulatory requirements described in 40 CFR 264 Subpart F. 40 CFR 264.91 identifies three required programs. 40 CFR 264.91(a)(1) requires compliance monitoring under 264.99 whenever hazardous constituents are detected in ground water. Detected is defined as statistically significant evidence of contamination. 40 CFR 264.91(a)(2) requires corrective action under 264.100 whenever a ground water protection standard is exceeded. Exceeded is defined as statistically significant evidence of increased contamination. 40 CFR 264.91(a)(3) requires corrective action under 40 CFR 264.100 whenever the ground water protection standard is exceeded between the compliance point and the downgradient facility boundary. 40 CFR 264.91(a)(4) requires institution of a detection monitoring program under 40 CFR 264.98 in all other cases. In order to achieve these regulatory objectives, supporting objectives (e.g., karst monitoring) must also be achieved in certain cases. Following is a description for each unit (ABG, ORR, and DR) of the regulatory and supporting objectives.

1.1.1 Ammunition Burning Ground

Compliance Monitoring [40 CFR 264.99]

Interim status ground water monitoring results have shown that hazardous constituents consisting of chlorinated organics, explosives, and metals have been detected in the ground water underlying the ABG. 40 CFR 264.92 requires the permit to contain conditions designed to ensure that hazardous constituents found in ground water do not exceed ground water protection standards established in the facility permit, beyond the compliance point. Compliance monitoring will be conducted to determine if the ground water protection standard is being met at the point of compliance.

Corrective Action Monitoring [40 CFR 264.100(d)]

NSWC Crane is conducting compliance monitoring to determine if the ground water protection standard is being exceeded at the point of compliance. Resampling under an approved QAP will establish a new background and plume delineation. Previous sampling quality assurance was not sufficient for risk assessment purposes. 40 CFR 264.91(a)(2) requires institution of a corrective action program under 40 CFR 264.100 whenever the ground water protection standard is exceeded. 40 CFR 264.91(a)(3) requires institution of a corrective action program whenever the ground water protection concentration limit is exceeded at wells between the point of compliance and the facility boundary. Exceeded is defined as statistically significant evidence of increased contamination. Results of the compliance monitoring at the point-of-compliance wells and the wells located beyond the point of compliance will be used to determine if corrective action is required. If corrective action is required, a permit modification to address corrective action will be submitted to the Regional Administrator.

Closure Monitoring [40 CFR 265.117(a)(1)]

Surface impoundments and a waste pile located at the ABG are undergoing closure and are subject to the post-closure care requirements of 40 CFR 265.117. During the post-closure period, ground water monitoring is required. The monitoring system will also serve to meet the requirements for closure monitoring.

Natural Attenuation Monitoring

Chlorinated organics and explosives have been detected in the ground water at the ABG. Preliminary evaluation of existing data indicates that natural attenuation of these compounds may be occurring. In

order to determine if natural attenuation is occurring, ground water will be monitored for chlorinated organics and explosives and their degradation products and indicator parameters. The information will be used to determine if natural attenuation is occurring and if contaminants have been attenuated below the ground water protection standard before reaching the facility boundary. If natural attenuation is occurring but contamination is above the ground water protection standard at the compliance point, a permit modification for a corrective action program meeting the requirements of 40 CFR 264.100 will be requested.

Karst Monitoring

Part of the ABG is underlain by a karst system. Studies have been conducted to determine the behavior of the karst system ground water flow patterns. The identification of the uppermost aquifer system and the number and locations of monitoring wells that meet the regulatory objectives described in 40 CFR 264 Subpart F were based on the results of studies of the karst system. Constituents, which are indicators of karst system behavior, will be monitored to determine if the karst system has changed. If changes occur in the karst system, the ground water monitoring system may have to be changed to meet the regulatory objectives in 40 CFR 264 Subpart F.

1.1.2 Old Rifle Range

Compliance Monitoring [40 CFR 264.99]

Interim status ground water monitoring results have shown that hazardous constituents consisting of explosives and metals have been detected in the ground water underlying the ORR. 40 CFR 264.92 requires the permit to contain conditions designed to ensure that hazardous constituents found in ground water do not exceed ground water protection standards established in the facility permit, beyond the compliance point. Compliance monitoring will be conducted at the ORR to determine if the ground water protection standard is being met at the point of compliance and at wells located beyond the point-of-compliance and the NSWC Crane boundary.

Corrective Action Monitoring [40 CFR 264.100(d)]

NSWC Crane is conducting compliance monitoring to determine if the ground water protection standard is being exceeded at the point of compliance. 40 CFR 264.91(a)(2) requires institution of a corrective action program under 40 CFR 264.100 whenever the ground water protection standard is exceeded. 40 CFR 264.91(a)(3) requires institution of a corrective action program whenever the ground water protection

concentration limit is exceeded at wells between the point of compliance and the facility boundary. Exceeded is defined as statistically significant evidence of increased contamination. Results of the compliance monitoring at the point-of-compliance wells and the wells located beyond the point of compliance will be used to determine if corrective action is required. If corrective action is required, a permit modification to address corrective action will be submitted to the Regional Administrator.

1.1.3 Demolition Range

Detection Monitoring [40 CFR 264.98]

Interim status ground water monitoring results have shown contamination in the active range area. However, contamination was not found at point-of-compliance ground water monitoring wells. Therefore, detection monitoring is triggered.

1.2 RECORDKEEPING [40 CFR 264.77(c) AND 264.97(j)]

NSWC Crane is required to keep records of all ground water monitoring data collected under 40 CFR 264 Subpart F. Records of ground water monitoring at the ABG, ORR, and DR will be maintained at NSWC Crane. All records related to ground water monitoring will be maintained at a central recordkeeping repository. Following is a description of the records that will be kept.

1.2.1 Field Records

Field records will include the following:

- Field notebooks
- Logbooks
- Chain-of-custody receipts
- Sample log sheets
- Sample forms
- Task modification requests
- Field analytical data
- Water levels
- Calibration Forms
- Sample Tags

- An evaluation of the performance of all monitoring devices including detailed proposals of the actions that are needed to restore or establish monitoring effectiveness at a unit or at an individual monitoring point.

- Maps showing the ground water constituent concentrations, flow rate and direction for the uppermost aquifer monitored, including interconnected aquifers.

- Ground water monitoring analytical data for all monitoring points in a tabular form, including methods of analysis.

- Summaries of the analytical data and statistical analyses performed as described in Section 10.4.

1.4 COMPLIANCE PERIOD [40 CFR 264.96]

Hazardous constituents have been detected in the uppermost aquifer underlying the ABG and the ORR. In compliance with 40 CFR 264.92, a ground water protection standard has been established. The standard contains concentration limits for the hazardous constituents. Compliance monitoring is taking place at the ABG and ORR to ensure that the ground water protection standard is not exceeded beyond the point of compliance. Compliance monitoring will take place for the active life of the unit and the closure period. If corrective action is underway at the end of this period, the compliance period will be extended until NSWC Crane can demonstrate that the ground water protection standard has not been exceeded for a period of 3 consecutive years.

1.5 RCRA HAZARDOUS CONSTITUENTS [40 CFR 264.93]

The list of hazardous constituents in 40 CFR 261 Appendix VIII was evaluated to determine if the proposed RCRA Appendix IX analyses described in the approved QAPP included all hazardous constituents that were waste constituents or formed as the result of open burning/open detonation (OB/OD) treatment and potentially emitted. Appendix 1-1 contains a summary of the evaluation.

Information regarding waste constituents and potential emission products was obtained from the approved RCRA Air Quality Assessment at the Ammunition Burning Grounds, Old Rifle Range, and Demolition Ground (TtNUS, 1997). A list of compounds potentially emitted was developed. No Appendix VIII hazardous constituents containing metals were identified as waste constituents or emission products. Three hazardous constituents (2,4-dinitrotoluene, 2,6-dinitrotoluene, and nitroglycerine) were identified as

explosive waste constituents. All are analyzed in the routine explosive analyses conducted for each monitoring event at all three units. Twenty-seven Appendix VIII hazardous constituents were identified as emission products potentially formed during treatment. All of these compounds, except diethylhexyl phthalate, are included in the Appendix IX monitoring list in the approved QAPP. Diethylhexyl phthalate is not a constituent of munitions. It may be emitted at extremely low levels in OD treatments. Due to the extremely low potential for the compound to be present as the result of OD treatment, it was not added to the Appendix IX monitoring list. Table 1-1 lists the Appendix VIII compounds potentially emitted.

1.6 NATURAL ATTENUATION DEMONSTRATION

The ground water underlying the ABG has been contaminated by explosives, chlorinated solvents and metals. A preliminary evaluation of existing data for the ABG indicates that this site is a candidate for natural and/or enhanced attenuation. A review of the hydrogeology at the ABG shows that the primary ground water flow path from the ABG is down the valley of Little Sulphur Creek. The contaminated ground water is moving through the alluvium of Little Sulphur Creek, the fractured sandstone of the Big Clifty, and fractures and solution cavities of the Beech Creek limestone and emerging as surface water in springs and seeps downgradient of the ABG. An area of solution cavities in the Beech Creek limestone acts as a ground water drain to focus contaminated ground water down the valley of Little Sulphur Creek. Drilling shows that the solution cavities are found primarily in the valley of Little Sulphur Creek and were not found in the ground water divides along the valley. The dense Elwren shale underlying the Beech Creek limestone helps to restrict downward flow of ground water in the ABG area and focuses the flow of ground water down the Little Sulphur Creek. Dye tracer tests conducted by Waterways Experiment Station and Indiana University provide data indicating that a large portion of the ground water exiting the ABG emerges as surface flow from Spring A. Ground water also enters Little Sulphur Creek through seeps in the alluvium. The contaminated ground water is attenuated as it moves through the Big Clifty, Beech Creek, and alluvial materials. As the ground water enters the area of the solution cavities, dilution occurs as clean ground water flows in from the sides of the valley. As the ground water and surface water move toward the installation boundary, the contaminants have been reduced to very low concentrations. Natural attenuation is discussed in detail in Section 7.4.

1.7 GROUND WATER PROTECTION STANDARD [40 CFR 264.92]

Hazardous constituents have been found during interim status monitoring in ground water under the ABG and the ORR. 40 CFR 264.92 requires that hazardous constituents detected in ground water from a regulated unit must not exceed concentration limits established under 40 CFR 264.94 in the uppermost

7.0 AMMUNITION BURNING GROUNDS

This section contains a description of the ground-water monitoring programs at the NSWC Crane ABG. Ground water monitoring is being conducted at the ABG to meet the requirements of 40 CFR 264 Subpart F.

7.1 GROUND WATER MONITORING PROGRAMS AT AMMUNITON BURNING GROUNDS [40 CFR 264 SUBPART F]

Following is a listing of the ABG ground water programs required in order to meet 40 CFR 264 Subpart F requirements.

Compliance Monitoring [40 CFR 264.99]

Interim status ground water monitoring results show that hazardous constituents have been detected in the ground water. Therefore, in compliance with 40 CFR 264.99, a compliance-monitoring program is being implemented at the ABG to determine whether the ABG is in compliance with the ground water protection standard established under 40 CFR 264.92.

Corrective Action Monitoring [40 CFR 264.100]

There is an existing plume of TCE and explosives within the ABG. A compliance-monitoring program has been established. In compliance with 40 CFR 264.100, corrective action monitoring is conducted to determine if this plume has moved beyond the point of compliance and a need exists for corrective actions.

Natural Attenuation Monitoring

Tetrachloroethylene, explosives, and metals in the ground water may be undergoing natural attenuation. Therefore, monitoring is being conducted to determine if natural attenuation is occurring and if monitored natural attenuation may constitute corrective action.

Karst Monitoring

Three aquifers are present at the ABG, one of which is a karst system. The locations of the monitoring points in the three aquifers and the frequency of monitoring are based on current understanding of the behavior of the aquifers, including the aquifer in the karst system. In order to determine if the aquifers, including the karst system, are behaving as currently understood, karst parameters are being monitored.

Closure Monitoring [40 CFR 264.117(a)(1)]

A waste pile and surface impoundments located within the ABG have been closed. These closed units are located among the active units. 40 CFR 264.117(a)(1)(i) and the closure permit issued by IDEM require closure monitoring. The ground water monitoring system at the ABG also serves closure-monitoring requirements.

Table 7-1 lists the wells, springs, and surface water monitoring points and describes the objectives for each monitoring point. Table 7-2 lists the monitoring points and analyses for each monitoring point for the first eight quarters. Figure 7-1 shows the locations of each monitoring point. Figure 7-2 is a close up of the wells located at the point of compliance and shows details of existing and closed treatment units at the ABG. Table 7-3 lists the monitoring points and analyses for each monitoring point for quarterly monitoring after the first eight quarters. Table 7-4 lists the compliance monitoring points for the annual Appendix IX monitoring. Following is a discussion of the regulatory requirements applicable to ground water monitoring and how these regulatory requirements are met.

7.2 COMPLIANCE MONITORING [40 CFR 264.99]

Compliance monitoring programs at the ABG must meet the requirements of 40 CFR 264.99.

40 CFR 264.99(a) requires that ground water be monitored to determine whether regulated units are in compliance with ground water protection standards under 264.92. The permit must specify the following: 1) A list of hazardous constituents identified under 264.93; 2) Concentration limits under 264.94 for each hazardous constituent. Concentration limits must not exceed background at the time that limit is specified in the permit, or the specified concentrations for constituents listed in Table 1 of 264.94, or alternate limits established by the Regional Administrator; 3) The compliance point under 264.95; and 4) the compliance period under 264.96.

the presence of the hazardous constituents. If confirmed, NSWC Crane will report the concentrations of these additional hazardous constituents to the Regional Administrator within 7 days and add them to the compliance-monitoring list. If NSWC Crane chooses not to resample the wells, the concentrations will be reported to the Regional Administrator within 7 days and added to the monitoring list.

40 CFR 264.99(h) contains requirements for notification and submission for a permit modification for establishment of a Corrective Action Program where concentration limits established under 264.94 are being exceeded. NSWC Crane will implement the procedures described in Section 1.3.2.3 if it is determined that the alternate concentration limits (risk-based target levels) listed in Table 1-2 are exceeded for any compliance well at the ABG.

40 CFR 264.99(i) contains procedures for demonstrations that sources other than the regulated unit caused the exceedence at the compliance point. NSWC Crane will notify the Regional Administrator that a demonstration will be made that the contamination is not due to the regulated unit If contamination resulting in exceedence(s) of the ground water protection standard at the compliance point is not due to the regulated unit (ABG). This notification will be made within 7 days after the completion of the analysis.

40 CFR 264.99(j) requires that, if it is determined that the compliance monitoring program no longer meets the requirements of Subpart F, within 90 days a permit application must be submitted for a permit modification for appropriate changes. NSWC Crane will evaluate the compliance monitoring program at the ABG each quarter. If it is determined that the ABG compliance monitoring program no longer meets 40 CFR 264 Subpart F requirements, NSWC Crane will submit a permit application to modify the ABG ground water monitoring program to meet the requirements of 264 Subpart F.

The ABG compliance-monitoring program must also meet the general ground water monitoring requirements described in 40 CFR 264.97. Compliance with general ground water monitoring requirements is described in Section 6.

7.3 CORRECTIVE ACTION MONITORING [40 CFR 264.100]

There is an existing plume of contamination within the ABG within the Beech Creek aquifer system. Compliance monitoring is being initiated at the point-of-compliance wells. Two downgradient Beech Creek aquifer wells, 03C25 and 03C30, are being monitored to determine if the existing plume in the ABG has moved beyond the point of compliance. Monitoring well 0C03, located in the Beaver Bend aquifer, is

being monitored to determine if there is any contamination in the Beaver Bend aquifer. The Beaver Bend aquifer is considered to be hydraulically separated from the upper Golconda Haney/Beech Creek Aquifer system. NSWC will evaluate results from these wells every sampling event. If it is determined that the existing plume of contamination has moved beyond the compliance point in the Beech Creek aquifer system or if contamination is found in the Beaver Bend aquifer in excess of the ground water protection standard, NSWC Crane will submit to the Regional Administrator an application for a permit modification to establish a Corrective Action Program meeting the requirements of 40 CFR 264.100. This application will be made within 180 days of the date that the determination is made. The application will include, at a minimum, the following information:

- A detailed description of corrective actions that will achieve compliance with the ground water protection standard specified in the permit.

- A plan for a ground water monitoring program that will demonstrate the effectiveness of corrective action.

7.4 NATURAL ATTENUATION MONITORING

Ground water in the Beech Creek aquifer has been contaminated with chlorinated solvents, explosives, and metals. A preliminary evaluation of the existing data indicates that the ABG site is a good candidate for remediation by natural and/or enhanced attenuation. Natural attenuation monitoring will be conducted to determine if natural attenuation is occurring in the ground water.

A review of the hydrogeolgy at the site shows that the primary ground water flow path from the ABG is down the valley of Little Sulphur Creek, the fractured sandstone of the Big Clifty, and the fractures and solution cavities of the Beech Creek limestone and emerging as surface water in springs and seeps downgradient of the ABG. An area of solution cavities in the Beech Creek Limestone acts as a ground water drain to focus contaminated ground water down the valley of Little Sulphur Creek. Extensive drilling shows that the solution cavities found primarily in the valley of Little Sulphur Creek were not found in the ground water divides along the valley. The dense Elwren shale underlying the Beech Creek limestone restricts downward flow of ground water in the ABG area and focuses the flow of ground water down the Little Sulphur Creek valley. Dye tracer tests provided data indicating that a large portion of the ground water exiting the ABG emerges as surface flow from Springs A and C. Ground water also enters Little Sulphur Creek through seeps in the alluvium. The contaminated ground water is attenuated as it moves through the Big Clifty, Beech Creek, and alluvial materials. As the ground water enters the area of the

solution cavities, dilution occurs as clean ground water flows in from the sides of the valley. As the ground water and surface water move toward the installation boundary, the contaminants are reduced to low concentrations.

Eight monitoring wells (03C25, 03C03, 03C04, 03B02, 03C10, 03C11, 03C12, and 03B04), Springs A and C, and Little Sulphur Creek (near the installation boundary and at Spring A) will be monitored. Parameters that will be monitored include TCE and degradation products, explosives and degradation products, and parameters that are indicative of conditions favorable to natural attentuation of explosives and chlorinated hydrocarbons will be monitored. Table 7-5 contains a listing of parameters to be monitored for natural attenuation and the rationale for their analysis.

Natural attenuation monitoring data will be evaluated to determine if there are clear and meaningful trends of decreasing contaminant mass and/or concentration over time. Graphs showing concentration trends over time will be prepared. Geochemical data will be used to evaluate the types of degradation that may be occurring. The presence of degradation products will be considered evidence that natural attenuation is occurring. The characterization data will be used to quantify the rates of contaminant sorption, dilution, or volatilization or to demonstrate and quantify the rates of biological degradation processes occurring at the ABG.

Natural attenuation monitoring will take place over a period of up to 2 years. If the data indicate that the TCE, explosives, and metals contaminants in the ground water or surface water have not been attenuated below risk-based levels before they reach the installation boundary, remediation activities such as phytoremediation will be considered. Plant enzyme mediated degradation of munitions-contaminated soils, sediments, and surface waters has been shown to reduce the concentration of these contaminants. If contaminants are present in ground water or surface water near the installation boundary above risk-based levels, NSWC Crane will submit a permit modification request to address additional remediation of ground water and/or surface water. NSWC Crane may also submit a permit modification request to modify the natural attentuation monitoring program based on the results of the initial screening.

7.5 KARST MONITORING

Part of the ABG is underlain by a karst system. Several studies of the karst system have been conducted by the United States Army Corps of Engineers Waterways Experiment Station (USACE – WES) and the Indiana University Department of Geological Sciences. Information regarding the karst system and

parameters to be monitored for karst behavior is contained in this section. Information on behavior of the karst system was obtained from a thesis that was prepared by Stephen J. Baedke, a graduate student at Indiana University. Appendix 7-1 contains this thesis.

Three aquifers are present at the ABG. One aquifer is a karst system. Karst systems show both temporal and spatial variation between diffuse-type and conduit-type ground water flow. The locations of the monitoring points are based on the current understanding of the aquifer system present at the ABG.

From highest to lowest, the three aquifer systems present at the ABG are the Golconda-Haney aquifer, the Beech Creek aquifer, and the Beaver Bend aquifer.

The Golconda-Haney aquifer consists of the Golconda and Haney limestones. The prevalent chemical character of ground water from this aquifer is Ca^{2+}-HCO_3. Figure 7-3 is a Piper diagram of water chemistry analysis for the Golconda/Haney aquifer. Underlying the aquifer is the Indian Springs shale, which acts as an aquiclude. Water entering this aquifer moves laterally along its base and eventually exits the aquifer via seeps. Once at the ground surface, water enters the Beech Creek aquifer either by percolation through the Big Clifty sandstone or by entering the headwaters of the Little Sulphur Creek. The Golconda-Haney aquifer is at a higher elevation than the operating area at the ABG; therefore, there is little potential for this aquifer to be contaminated by ABG operations.

The Beech Creek aquifer consists of the Big Clifty sandstone and the Beech Creek limestone. Underlying the aquifer is the Elwren shale, which acts as an aquiclude. The prevalent "natural" chemical character of the ground water is Ca^{2+} + Mg^{2+} -HCO_3, which is expected from a carbonate terraine. The determination of chemical character of the Beech Creek aquifer is complicated by a plume of Mg^{2+} and SO_4^{2-} from past practices and the presence of Na^+, K^+, and Cl^- in wells near roads where salting occurs in the winter. Figure 7-4 is a Piper diagram of water chemistry analysis for the Beech Creek aquifer. Figure 7-5 is a Piper diagram of water chemistry analysis from "uncontaminated" wells in the Beech Creek aquifer. This figure was constructed by removing wells that contained anamously high Mg^{2+}, SO_4^{2-}, Cl^-, and Na^+. The Beech Creek aquifer is partially open to recharge from surface water infiltration during precipitation. Precipitation falling on the ABG drains into the headwaters of Little Sulphur Creek. As surface waters travel down Little Sulphur Creek, the Indian Springs shale pinches out and the Big Clifty sandstone comes to outcrop. Here, surface water percolates into the Big Clifty sandstone.

11.0 CORRECTIVE ACTION PROGRAM [40 CFR 270.14(c)(8)]

Corrective action for Solid Waste Management Units (SWMUs) is discussed in the RCRA Part B permit application submitted by NSWC Crane in November 1997, and is included in the operating permit for the Central Storage Facility and Incinerator.

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 Mgr.
TITLE

9/22/99
DATE