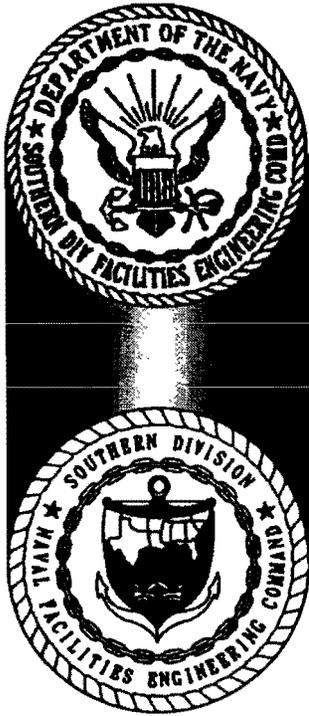


N61165.AR.004230  
CNC CHARLESTON  
5090.3a

INTERIM MEASURE WORK PLAN IN-SITU CHEMICAL OXIDATION OF DDD IN  
GROUNDWATER SOLID WASTE MANAGEMENT UNIT 38 (SWMU 38) ZONE A WITH  
TRANSMITTAL CNC CHARLESTON SC  
12/20/2001  
CH2M HILL

# INTERIM MEASURE WORK PLAN

## In-situ Chemical Oxidation of DDD in Groundwater SWMU 38, Zone A



***Charleston Naval Complex  
North Charleston, South Carolina***

SUBMITTED TO  
***U.S. Navy Southern Division  
Naval Facilities Engineering Command***

PREPARED BY  
***CH2M-Jones***

*December 2001*

*Revision 0  
Contract N62467-99-C-0960  
158814.ZA.PR.03*

# INTERIM MEASURE WORK PLAN

## In-situ Chemical Oxidation of DDD in Groundwater SWMU 38, Zone A



***Charleston Naval Complex  
North Charleston, South Carolina***

SUBMITTED TO  
***U.S. Navy Southern Division  
Naval Facilities Engineering Command***

PREPARED BY  
***CH2M-Jones***

*December 2001*

*Revision 0  
Contract N62467-99-C-0960  
158814.ZA.PR.03*



**CH2MHILL**

**CH2M HILL**  
3011 S.W. Williston Road  
Gainesville, FL  
32608-3928  
Mailing address:  
P.O. Box 147009  
Gainesville, FL  
32614-7009  
Tel 352.335.7991  
Fax 352.335.2959

December 20, 2001

Mr. David Scaturo  
Division of Hazardous and Infectious Wastes  
South Carolina Department of Health and  
Environmental Control  
Bureau of Land and Waste Management  
2600 Bull Street  
Columbia, SC 29201

Re: IM Work Plan (Revision 0) – SWMU 38, Zone A

Dear Mr. Scaturo:

Enclosed please find four copies of the IM Work Plan (Revision 0) for SWMU 38 in Zone A of the Charleston Naval Complex (CNC). This report has been prepared pursuant to agreements by the CNC BRAC Cleanup Team for completing the RCRA Corrective Action process.

The principal author of this document is Jim Edens. Please contact him at 352/335-5877, extension 2491, if you have any questions or comments.

Sincerely,

CH2M HILL

Dean Williamson, P.E.

cc: ✓ Rob Harrell/Navy, w/att  
Gary Foster/CH2M HILL, w/att

**Certification Page for Interim Measure Work Plan (Revision 0) –  
SWMU 38, Zone A**

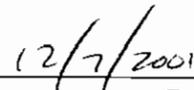
**In-Situ Chemical Oxidation of Groundwater**

I, Dean Williamson, certify that this report has been prepared under my direct supervision. The data and information are, to the best of my knowledge, accurate and correct, and the report has been prepared in accordance with current standards of practice for engineering.

South Carolina

P.E. No. 21428

  
\_\_\_\_\_  
Dean Williamson, P.E.

  
\_\_\_\_\_  
Date

# 1 Contents

---

2 Section	Page
3 <b>Acronyms and Abbreviations</b> .....	vi
4 <b>1.0 Introduction</b> .....	1-1
5     1.1 Purpose and Objectives of the Interim Measure Work Plan.....	1-1
6     1.2 Organization of the Interim Measure Work Plan.....	1-2
7 Figure 1-1 Site Location Map of SWMU 38 .....	1-3
8 <b>2.0 Site Characterization</b> .....	2-1
9 Table 2-1 Summary of Surface Soil Detects .....	2-3
10 Table 2-2 Summary of Subsurface and Saturated Soil Detects.....	2-4
11 Table 2-3 Summary of Groundwater Detects.....	2-5
12 Figure 2-1 SWMU 38 Soil Sample Locations.....	2-6
13 Figure 2-2 Maximum Extent of Soil within Shallow Aquifer with Pesticides above SSLs....	2-7
14 <b>3.0 Technical Approach</b> .....	3-1
15     3.1 Geo-Cleanse® Process .....	3-1
16     3.2 Fenton’s Reagent and Pesticide Treatment .....	3-2
17     3.3 Treatment Goals .....	3-3
18     3.4 Target Treatment Area .....	3-4
19         3.4.1 Treatment Depth Interval.....	3-4
20     3.5 Geo-Cleanse Injection Equipment .....	3-4
21     3.6 Injector Installation .....	3-5
22         3.6.1 Utility Clearance.....	3-5
23         3.6.2 Injector Construction .....	3-5
24     3.7 Performance and Process Monitoring.....	3-6
25     3.8 Treatment Program Procedures .....	3-6
26         3.8.1 Sequence of Events .....	3-6
27         3.8.2 Duration of Treatment .....	3-7
28         3.8.3 Reagents .....	3-7
29         3.8.4 Process Monitoring Parameters.....	3-9
30     3.9 Reporting.....	3-11
31     3.10 Permitting.....	3-11

1	3.10.1 SCDHEC Underground Injection Control Permit Application .....	3-11
2	Figure 3-1 Benzene Oxidation Pathway (GCI).....	3-12
3	Figure 3-2 Injector Locations at IM Treatment Area .....	3-13
4	Figure 3-3 Geo-Cleanse Treatment Rig Schematic (GCI) .....	3-14
5	Figure 3-4 Geo-Cleanse® Patented Injector and Mixing Head Design Schematic (GCI) ....	3-15
6	Figure 3-5 Example Construction Detail for Injector (GCI) .....	3-16
7	Figure 3-6 Example Soil Boring and Well Construction Log (GCI).....	3-17
8	<b>4.0 Investigation-Derived Waste.....</b>	<b>4-1</b>
9	<b>5.0 Future Site Activities.....</b>	<b>5-1</b>
10	<b>6.0 References.....</b>	<b>6-1</b>
11		
12	<b>Appendices</b>	
13	<b>A Construction Details for A038GW001</b>	
14	<b>B Data Summary Tables</b>	
15	<b>C Data Validation Summary</b>	

# 1 Acronyms and Abbreviations

---

2	CA	Corrective Action
3	CFR	<i>Code of Federal Regulations</i>
4	CMS	Corrective Measures Study
5	CNC	Charleston Naval Complex
6	COC	Chemical of concern
7	CSAP	Comprehensive Sampling and Analysis Plan
8	DDD	dichlorodiphenyldichloroethane
9	DDT	dichlorodiphenyltrichloroethane
10	DET	Environmental Detachment Charleston
11	DMP	Data Management Plan
12	EnSafe	EnSafe Inc.
13	EPA	U.S. Environmental Protection Agency
14	ESDSOPQAM	Environmental Services Division <i>Standard Operating Procedures and</i>
15		<i>Quality Assurance Manual</i>
16	ft bls	Feet below land surface
17	GCI	Geo-Cleanse International, Inc.
18	IDW	Investigation-derived waste
19	IM	Interim measure
20	KOH	Potassium hydroxide
21	MCS	Media cleanup standard
22	µg/L	Micrograms per liter
23	mg/kg	Milligrams per kilogram
24	mg/L	Milligrams per liter
25	NFA	No further action
26	PCB	Polychlorinated biphenyl
27	PPE	Personal protective equipment
28	ppm	Part per million

1	QAP	Quality Assurance Plan
2	RCRA	Resource Conservation and Recovery Act
3	RFI	RCRA Facility Investigation
4	SCDHEC	South Carolina Department of Health and Environmental Control
5	SPORTENVDET-	
6	CHASN	Supervisor of Shipbuilding, Conversion and Repair, United States
7		Navy, Portsmouth Va. Environmental Detachment Charleston
8	SWMU	Solid Waste Management Unit
9	WP	Work plan

Section 1.0

---

# 1.0 Introduction

---

## 1.1 Purpose and Objectives of the Interim Measure Work Plan

The results of the Zone A RCRA Facility Investigation (RFI) activities conducted at Solid Waste Management Unit (SWMU) 38 identified the presence of pesticide-contaminated soil and groundwater at the site. An Interim Measure Work Plan (IM) was completed by the Supervisor of Shipbuilding, Conversion and Repair, United States Navy, Portsmouth Va. Environmental Detachment Charleston (SPORTENVDETCHASN) in October 1998 at SWMU 38 to removed pesticide-contaminated soils. The areal extent of the excavation is presented in Figure 1-1. The excavation depth was four to five feet, which is below the top of the water table. As part of the excavation activities monitoring well A038GW001, the well in which contaminated groundwater was identified, was abandoned and removed.

Environmental Detachment Charleston (DET) collected post-excavation soil samples at the floor of the excavation. Of the final three floor samples collected, two showed pesticides (dichlorodiphenyldichloroethane [DDD] and dichlorodiphenyltrichloroethane [DDT]) that exceeded their respective media cleanup standard (MCS) developed by the Navy/EnSafe Inc. (EnSafe) team (DET, 1998). Further excavation was not performed because the excavation was below the top of the water-bearing zone.

Historical data from the removed monitoring well indicated that DDD and DDT were present at concentrations that exceed their respective risk-based concentrations (RBCs) (DDD: 0.28 micrograms per liter [ $\mu\text{g}/\text{L}$ ] and DDT: 0.2  $\mu\text{g}/\text{L}$ ) in groundwater. Based on these results, a new monitoring well was installed by CH2M-Jones at approximately the same location as the monitoring well that was removed during the DET's IM (see *Corrective Measures Study Work Plan – Source Area Delineation for SWMU 38, Zone A*, CH2M-Jones, 2001). The new monitoring well, A038GW001, was sampled in September 2001. Analytical results indicate that DDD (0.97  $\mu\text{g}/\text{L}$ ) is present above its RBC (0.28  $\mu\text{g}/\text{L}$ ) in site groundwater. The results of the subsurface soil sampling conducted at the same time as the well installation did not identify pesticide-contaminated soil.

The RCRA Corrective Action (CA) process allows for the implementation of an IM to control or minimize ongoing threats to human health or the environment (61 CFR 19432 [1996]). This IM Work Plan (IM WP) describes how the remediation of DDD-contaminated groundwater will be accomplished at SWMU 38.

- 1 The remediation of the DDD in site groundwater may be the final remedy for SWMU 38.  
2 However, if additional remedial measures are necessary, the activities conducted as part of  
3 this IM are expected to be compatible with the final remedy selected for SWMU 38.  
4 After completion of the IM at this site, the RCRA Corrective Measures Study (CMS) process  
5 will be followed to identify appropriate final remedial measures for SWMU 38, should  
6 additional corrective action be necessary after the IM is completed.

## 7 **1.2 Organization of the Interim Measure Work Plan**

8 This IM WP consists of the following sections, including this introductory section:

9 **1.0 Introduction** —Presents the purpose of the report and background information relating  
10 to the proposed investigation.

11 **2.0 Site Characterization** —Provides the results of the IM characterization.

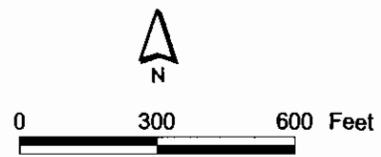
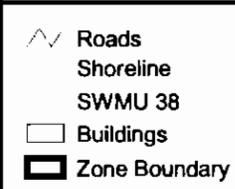
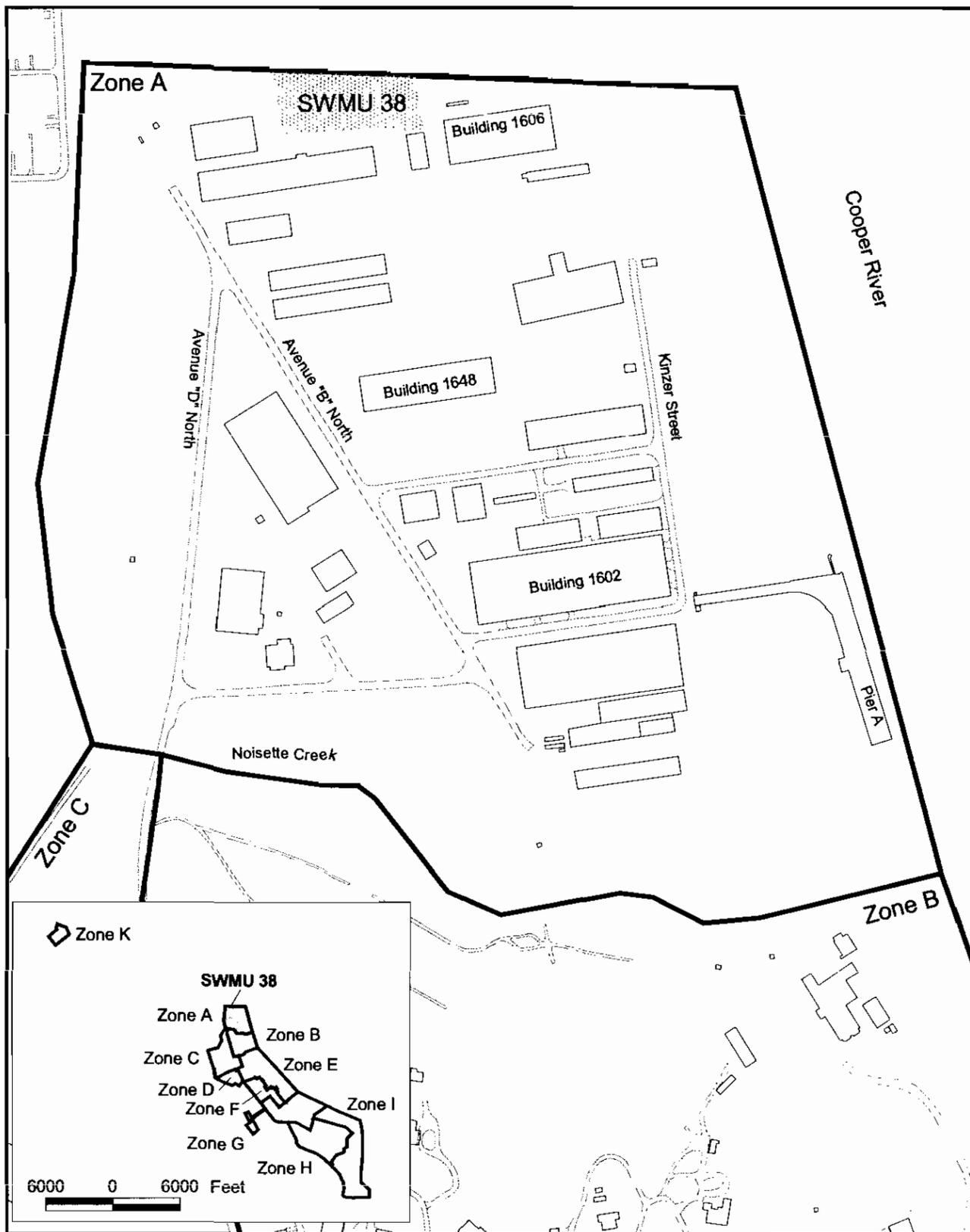
12 **3.0 Technical Approach** — Describes the technical approach for completing the IM at  
13 SWMU 38.

14 **4.0 Investigation-Derived Waste** — Describes the procedures to be implemented for  
15 management of the investigation-derived waste (IDW).

16 **5.0 Future Site Activities** — Describes additional investigative activities planned at the site.

17 **6.0 References** — Lists the references used in this document.

18 All tables and figures appear at the end of their respective sections.



**Figure 1-1**  
**SWMU 38**  
 Zone A  
 Charleston Naval Complex

**CH2MHILL**

**Section 2.0**

---

## 2.0 Site Characterization

---

The *Zone A RFI Report, Revision 0* (EnSafe, 1998) for SWMU 38 concluded that surface soil chemicals of concern (COCs) at SWMU 38 included several metals (aluminum, arsenic, and beryllium), a polychlorinated biphenyl (PCB) (Aroclor-1260), and chlorinated pesticides (DDD, DDE, and DDT). No COCs were identified for the subsurface soils of SWMU 38 in the RFI Report. Groundwater COCs at SWMU 38 were identified as metals (arsenic and thallium) and chlorinated pesticides (DDD and DDT).

An IM was conducted the DET at SWMU 38. It was completed in October 1998 and was intended to remove pesticide-contaminated soil from the site. Soil containing DDT and DDE concentrations above 6.5 milligrams per kilogram (mg/kg), and DDD concentrations greater than 9.2 mg/kg were targeted for removal.

The DET removed approximately 500 cubic yards (y<sup>3</sup>) of pesticide-contaminated soil. Confirmatory sampling found that one surface soil sample (03803701) collected along the fence line between the Charleston Naval Complex (CNC) and the Hess Oil property had a residual DDT concentration of 50.9 mg/kg, which is above the MCS of 6.5 mg/kg. Additionally, two confirmatory samples (038S03001: DDD at 19.0 mg/kg and DDT at 41.6 mg/kg; 038S03101: DDD at 123 mg/kg and DDT at 388 mg/kg) collected along the bottom of the excavation had elevated concentrations of DDD and DDT. The excavation was terminated below the top of the water-bearing zone. The excavated pit was back-filled with clean fill.

CH2M-Jones conducted additional field activities as described in the CMS WP (CH2M-Jones, 2001) to further evaluate the presence of pesticides in environmental media at SWMU 38. In September and October 2001 eleven soil samples from six locations were collected. Also, monitoring well A038GW001 was replaced and subsequently sampled (the well construction details are included in Appendix A).

Soil samples and the groundwater sample were analyzed for pesticides. Samples were collected according to the CMS WP and the Comprehensive Sampling and Analysis Plan (CSAP) portion of the RFI WP (EnSafe, 1996). Summaries of the analytical results are provided in Tables 2-1, 2-2 and 2-3 for surface soil, subsurface (and saturated) soil, and groundwater respectively. Sample locations and the approximate area of the DET's IM are shown in Figure 2-1. The complete data are provided in Appendix B, and the data validation summary is provided in Appendix C.

1 One surface soil sample (038SB01701) was collected at the location (A03803701) where the  
2 DET had previously found DDT at a concentration of 50.9 mg/kg. DDD, DDE, DDT and  
3 dieldrin were detected in the sample, but at concentrations below screening criteria (see  
4 Table 2-1). Based on this information, pesticides at this location are not considered to be  
5 contributing to the presence of DDD in site groundwater.

6 DET confirmation sampling indicated that two samples collected below the water table  
7 (038S03001 and 038S03101) contained DDD and DDT above their respective soil screening  
8 levels (SSLs), with a dilution attenuation factor (DAF)=10 (DDD at 8.0 mg/kg and DDT at  
9 16.0 mg/kg). Because these soils are below the water table, these data were used to identify  
10 the likely extent of DDD-impacted groundwater.

11 CH2M-Jones collected the remaining ten soil samples from five locations to delineate the  
12 extent of pesticide-impacted environmental media in the vicinity of 038S03001 and  
13 038S03101 (DET confirmation samples). Each location was sampled one foot above, and one  
14 foot below, the level of the water table. The samples collected above the water table were  
15 collected to verify that pesticide concentrations in subsurface soil were below their  
16 respective SSLs. The saturated samples (below the water table) were collected to assess the  
17 extent of pesticide-impacted groundwater. Water was encountered at about 4 to 5 feet  
18 below land surface (ft bls). No pesticides were detected at concentrations that exceed their  
19 respective SSLs in these samples, indicating that the areal extent of groundwater containing  
20 pesticides above screening criteria is limited. The maximum area potentially exceeding the  
21 SSLs is represented by an elliptical area measuring 52 feet long by 16 feet wide, as shown on  
22 Figure 2-2.

23 A groundwater sample collected and analyzed for pesticides from the replacement  
24 monitoring well (A038GW001) indicated that DDD (0.97 µg/L) is currently present above  
25 its RBC (0.28 µg/L) in site groundwater.

26 Because groundwater results are above screening criteria, CH2M-Jones is recommending  
27 remediation of the groundwater in the vicinity of monitoring well A038GW001 using  
28 chemical oxidation (Fenton's reagent).

**TABLE 2-1**  
 Pesticides Detected in Surface Soil  
*IM Work Plan, SWMU 38, Zone A, Charleston Naval Complex*

Chemical	Location	Sample ID	Date Collected	Concentration (mg/kg)	Qualifier	RBC (HI=1)	SSL (DAF=10) <sup>a</sup>
Dieldrin	A038SB017	038SB01701	09/27/2001	0.00073	J	0.04	0.002
p,p'-DDT	03803701*	3803701	1998	50.9	NA	1.9	16
p,p'-DDD	A038SB017	038SB01701DL	09/27/2001	0.12	=	2.7	8
p,p'-DDE	A038SB017	038SB01701DL	09/27/2001	0.11	=	1.9	27
p,p'-DDT	A038SB017	038SB01701DL	09/27/2001	0.64	=	1.9	16

<sup>a</sup> Soil Screening Levels (SSLs) are adjusted to a Dilution Attenuation Factor (DAF) of 10.

\* indicates that the samples were collected by the DET during the IM.

= indicates that the compound was detected, the reported concentration is equal to the sample concentration.

J indicates that the compound was detected, the reported concentration is estimated

NA indicates that the information is not available or not applicable.

**TABLE 2-2**  
 Pesticides Detected in Subsurface and Saturated Soil  
 IM Work Plan, SWMU 38, Zone A, Charleston Naval Complex

Chemical	Location	Sample ID	Date Collected	Concentration (mg/kg)	Qualifier	SSL (DAF=10) <sup>a</sup>
p,p'-DDD	038S03001*	038S03001	1998	19	NA	8
	038S03101*	038S03101	1998	123	NA	
	038S03201*	038S03201	1998	0.992	NA	
	A038SB018	038SB01804	10/09/2001	0.0016	J	
	A038SB018	038SB01806	10/09/2001	0.00057	J	
	A038SB019	038SB01904	10/09/2001	0.0014	J	
	A038SB021	038SB02104	10/09/2001	0.00049	J	
	A038SB022	038SB02203	10/09/2001	0.0012	J	
	A038SB022	038SB02204	10/09/2001	0.001	J	
p,p'-DDT	A038SB022	038SB02203	10/09/2001	0.0015	J	16
	038S03001*	038S03001	1998	41.6	NA	
	038S03101*	038S03101	1998	388	NA	
	038S03201*	038S03201	1998	4.63	NA	
Alpha BHC (Alpha Hexachlorocyclohexane)	A038SB022	038SB02204	10/09/2001	0.00023	J	0.00025

The last two digits of the sample ID indicate the sample depth. Depths greater than 4 ft bls are generally saturated samples.

<sup>a</sup> Soil Screening Levels (SSLs) are adjusted to a Dilution Attenuation Factor (DAF) of 10.

\* indicates that the samples were collected by the DET during the IM.

= indicates that the compound was detected, the reported concentration is equal to the sample concentration.

J indicates that the compound was detected, the reported concentration is estimated.

NA indicates that the information is not available or not applicable.

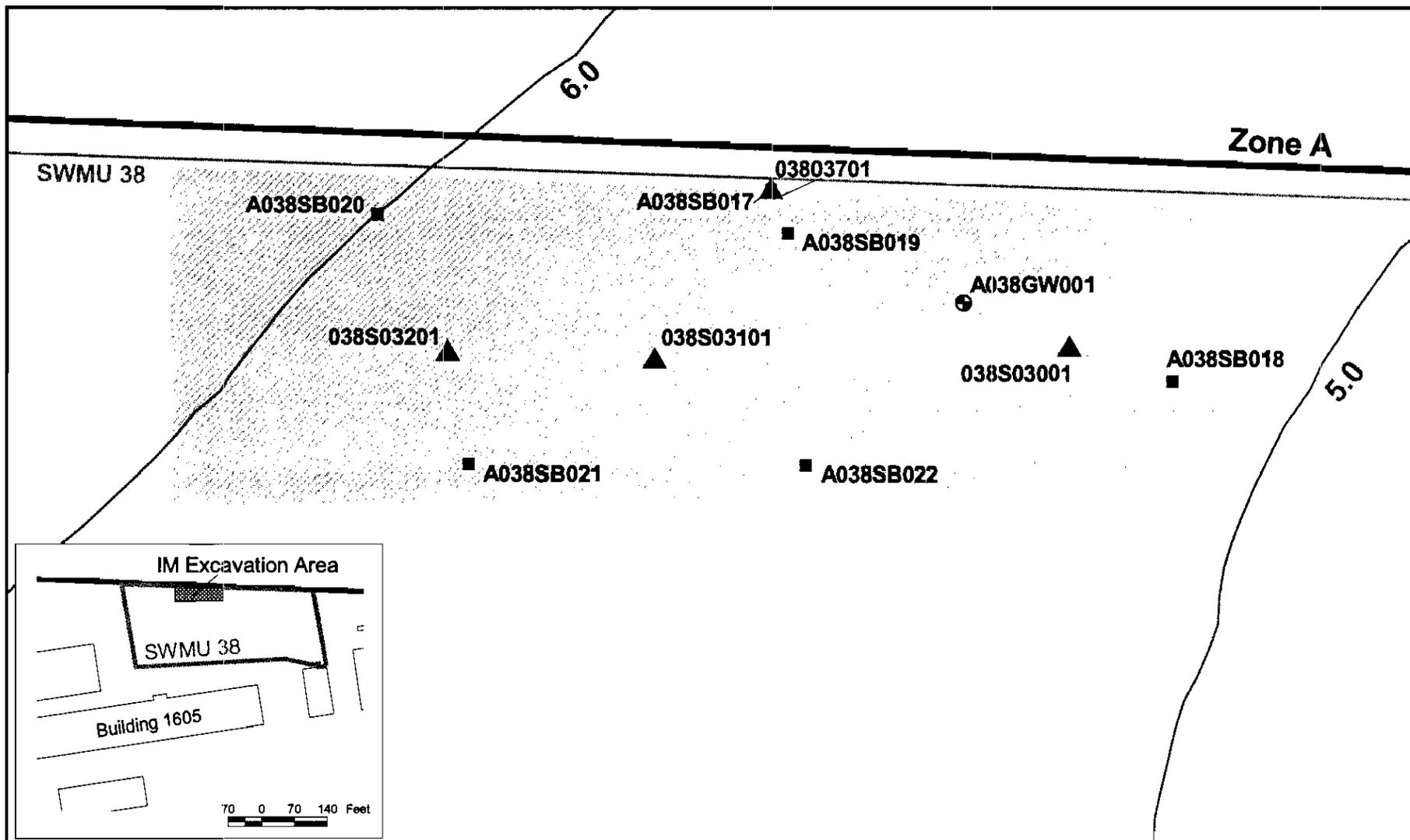
**TABLE 2-3**  
**Pesticides Detected in Groundwater**  
*IM Work Plan, SWMU 38, Zone A, Charleston Naval Complex*

Chemical	Location	Sample	Date	Concentration		RBC	
		ID	Collected	(µg/L)	Qualifier	(HI=1)	MCL
p,p'-DDD	A038GW001	038GW001 L1RE	09/27/2001	0.97	=	0.28	NA

= indicates that the compound was detected, the reported concentration is equal to the sample concentration.

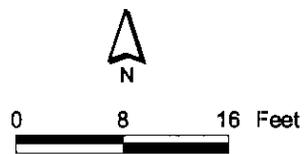
J indicates that the compound was detected, the reported concentration is estimated

NA indicates that the information is not available or not applicable.

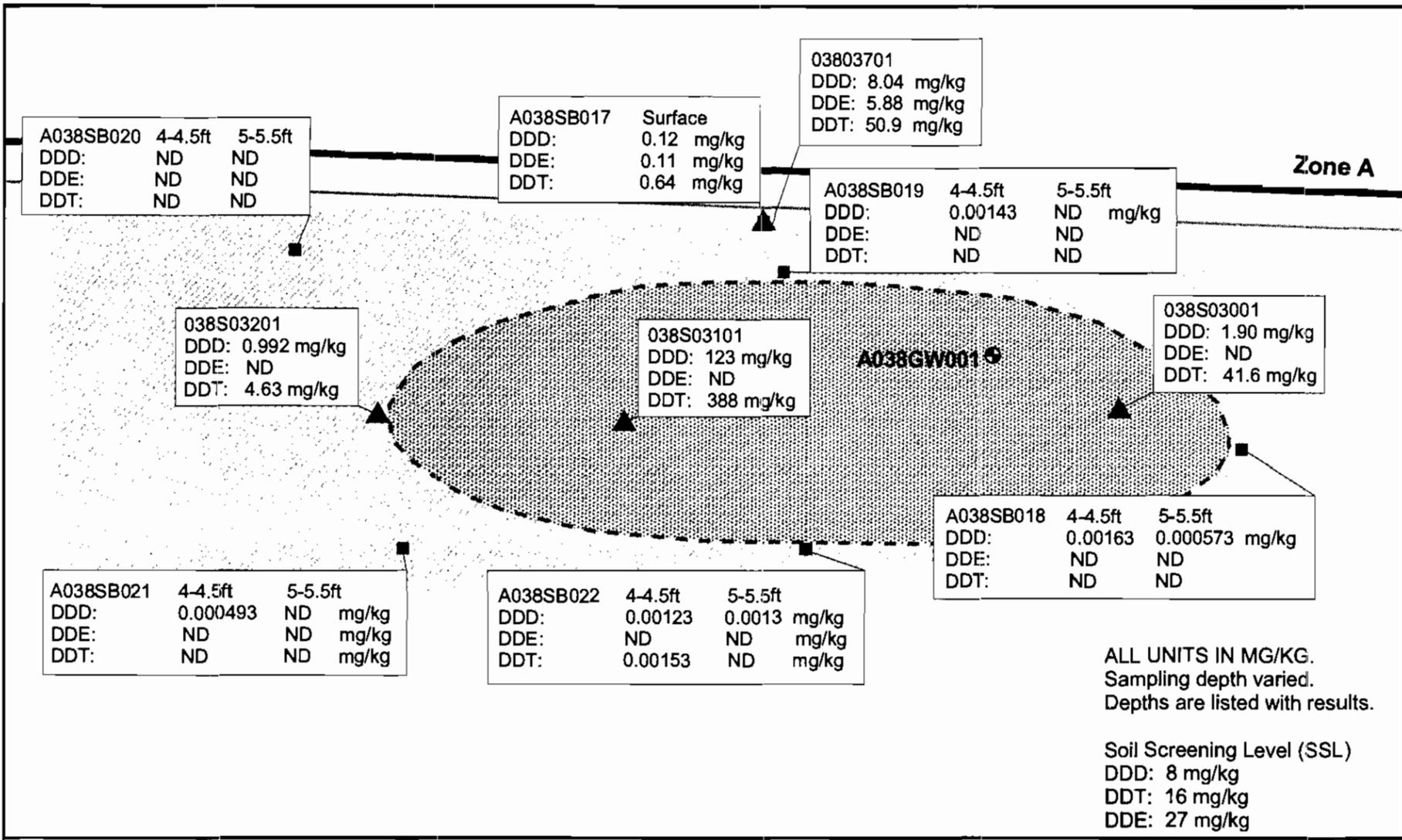


**Figure 2-1**  
 Soil Sample Locations  
 SWMU 38, Zone A  
 Charleston Naval Complex

- ▲ DET IM Confirmation Samples
- ⊕ Groundwater Well
- CH2M - Jones Soil Samples
- ∨ Groundwater Potentiometric Contours
- SWMU Boundary
- Buildings
- Zone Boundary
- ▨ IM Excavation Area



**CH2MHILL**



**Figure 2-2**  
Maximum Extent of Soil within Shallow Aquifer with Pesticides Above SSLs  
SWMU 38, Zone A  
Charleston Naval Complex

**CH2MHILL**

▲ DET IM Confirmation Samples      ○ IM Excavation Area  
 ● Groundwater Well                      □ SWMU Boundary  
 ■ Soil Samples                              □ Buildings  
 ▭ Zone Boundary  
 ▨ Estimated Maximum Area with DDD & DDT Above SSLs

0 6 12 Feet

**Section 3.0**

---

## 3.0 Technical Approach

---

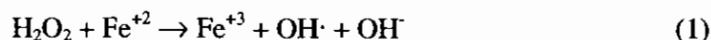
The proposed IM for groundwater at SWMU 38 will involve the use of in-situ chemical oxidation. Geo-Cleanse International, Inc. (GCI) is the remediation contractor that will implement the IM at SWMU 38. The sections below address the following issues:

- The Geo-Cleanse® process
- Applicability of Fenton's reagent to DDD and DDT
- Treatment goals
- Treatment area
- Injection equipment
- Injector installation
- Performance and process monitoring
- Treatment program procedures
- Reporting
- Permitting

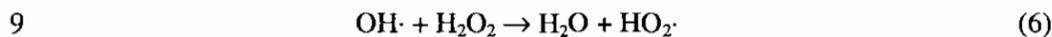
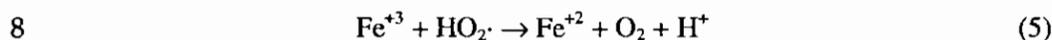
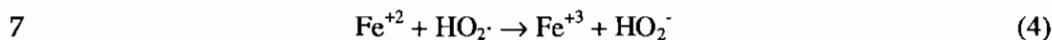
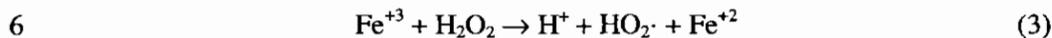
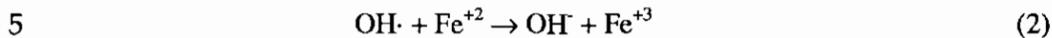
### 3.1 Geo-Cleanse® Process

The Geo-Cleanse® Process is a patented technology that simultaneously injects hydrogen peroxide and trace quantities of metallic salts under pressure to the subsurface in order to destroy organic contaminants in soil and groundwater. U.S. patents 5,525,008 and 5,611,642 protect the technology. The Geo-Cleanse® Process delivers a calculated charge of hydrogen peroxide and catalyst to the contaminated region via specially designed injection equipment consisting of mixing heads and subsurface injectors. The injection methodology and equipment are the keys to the Geo-Cleanse® Process. The chemistry involved is based upon Fenton's reagent. Fenton's reagent oxidizes organic contaminants to carbon dioxide and water, plus chloride (in the case of chlorinated compounds).

In 1894, H.J.H. Fenton reported that malic acid was rapidly oxidized by hydrogen peroxide in the presence of iron salts. Haber and Weiss (1934) identified the oxidation mechanism resulting from mixtures of hydrogen peroxide and ferrous iron (referred to as Fenton's reagent) as a hydroxyl free radical (OH·) formed by the following reaction:



1 Where  $\text{H}_2\text{O}_2$  is hydrogen peroxide,  $\text{Fe}^{+2}$  is ferrous iron,  $\text{Fe}^{+3}$  is ferric iron,  $\text{OH}\cdot$  is hydroxyl  
2 free radical, and  $\text{OH}^-$  is hydroxyl ion. Fenton's reagent chemistry is complex, involving a  
3 number of additional reactions producing both oxidants and reductants that contribute to  
4 contaminant destruction (e.g., Watts et al., 1999):



10

11 Where  $\text{HO}_2\cdot$  is hydroperoxyl radical,  $\text{HO}_2^-$  is hydroperoxyl anion,  $\text{O}_2$  is molecular oxygen,  
12  $\text{H}^+$  is the hydrogen ion, and  $\text{H}_2\text{O}$  is water. Additional reactions occur with organic  
13 compounds. The suite of reactions associated with Fenton's reagent is complex, but is very  
14 effective in destroying many organic compounds dissolved in groundwater, sorbed to soil  
15 particles, or existing as non-aqueous phase liquids in subsurface environments.

16 The hydroxyl free radical generated by Fenton's reagent is a powerful, non-selective  
17 oxidant. Oxidation of an organic compound by Fenton's reagent is a rapid and exothermic  
18 (heat-producing) reaction. Rate constants for reactions of hydroxyl free radical with  
19 common environmental pollutants are typically in the range of  $10^7$  to  $10^{10} \text{ M}^{-1}\text{s}^{-1}$  (e.g.,  
20 Buxton et al., 1988; Haag and Yao, 1992), and 100-percent mineralization is generally  
21 completed in minutes. Intermediate compounds are primarily naturally occurring  
22 carboxylic acids. The end products of oxidation are primarily carbon dioxide and water,  
23 plus chloride (in the case of chlorinated compounds). None of the injected reagents poses an  
24 environmental hazard. Unconsumed hydrogen peroxide naturally degrades to oxygen and  
25 water within a few days of injection.

## 26 **3.2 Fenton's Reagent and Pesticide Treatment**

27 Fenton's reagent oxidizes chlorinated aromatic compounds such as DDD and DDT to  
28 substituent carbon dioxide, water, and chloride, via an oxidation pathway that involves  
29 carboxylic acids. The oxidation pathway of benzene is well known and provides a model

1 for the oxidation pathway of other aromatic compounds (Merz and Waters, 1949; Lindsay  
2 Smith and Norman, 1963; Walling and Johnson, 1975; Edwards and Curci, 1992 [full  
3 reference to be provided]; Scheck and Frimmel, 1995). The rate constant for oxidation of  
4 benzene by hydroxyl free radicals is reported as  $7.8 \times 10^9 \text{ M}^{-1}\text{s}^{-1}$  (Buxton et al., 1988).  
5 Reaction of benzene with hydroxyl free radicals produces short-lived and highly reactive  
6 aromatic intermediates. The initial attack is hydroxylation to phenol and subsequent  
7 oxidation to orthobenzoquinone. The benzene oxidation pathway is presented as Figure 3-1.

8 Once orthobenzoquinone is formed, ring tension and oxidizing agents rapidly force fission  
9 of the aromatic ring to produce muconic acid, a linear carboxylic acid. The pathway then  
10 proceeds through a series of intermediate carboxylic acids to carbon dioxide. Hydroxyl  
11 radicals do not readily oxidize certain carboxylic acids produced as intermediate oxidation  
12 products from organic compounds, thus mineralization may be incomplete although no  
13 hazardous intermediate compounds are formed. For example, oxalic acid produced as an  
14 intermediate product of Fenton's reagent oxidation of benzene is not readily oxidized in the  
15 absence of light (e.g., Karpel vel Leitner, 1997).

16 The oxidation pathways for DDD and DDT are not well known, but are anticipated to be  
17 very similar to that of benzene. This is because hydroxyl radicals preferentially attack  
18 aromatic ring structures (dechlorination occurs by other mechanisms) and rate constants are  
19 not strongly affected by the degree of chlorination (Sedlak and Andren, 1991). Watts et al.  
20 (1994 [full reference to be provided], 1997) report rapid oxidation of polychlorinated  
21 benzenes (including trichlorobenzene isomers) sorbed to several different soil matrices.

### 22 **3.3 Treatment Goals**

23 The primary objective for the in-situ chemical oxidation is the reduction of pesticide levels  
24 in groundwater to levels below their respective RBCs (DDD:  $0.28 \mu\text{g}/\text{L}$  and DDT:  $0.2 \mu\text{g}/\text{L}$ )  
25 at the site. Factors that affect contaminant treatment include effective radius of influence,  
26 sustainable injection rate, oxidation efficiency, and the effect of site-specific geological and  
27 hydrogeological conditions on the overall treatment. Because of the small area of impacted  
28 environmental media at SWMU 38, these factors are not expected to limit treatment at the  
29 site. The approximate extent of impacted soil with pesticides above their SSLs was  
30 presented in Figure 2-2 of this IM WP.

## 1    **3.4 Target Treatment Area**

2    For the IM, three injectors will be installed near the locations illustrated in Figure 3-2. These  
3    locations are expected to provide treatment for the entire treatment area (see Figure 2-2).

### 4    **3.4.1 Treatment Depth Interval**

5    For the IM, a total of two injectors will be installed with a screened interval approximately 7  
6    to 10 ft bls. This depth is considered appropriate because DDD and DDT are not expected to  
7    migrate significantly below the level of the water table, which was encountered at  
8    approximately 4 ft bls during the DET's IM at SWMU 38.

## 9    **3.5 Geo-Cleanse Injection Equipment**

10   GCI will stage a mobile treatment unit at the site. A schematic of a typical mobile treatment  
11   unit is provided in Figure 3-3. Hydrogen peroxide is staged at the site in a tanker.  
12   Additional support services at the site include water and power.

13   The GCI mobile treatment unit includes tanks, pumps, gauges, and flow control valves to  
14   deliver reagents safely and effectively to mixing heads installed on the injectors. Safety  
15   features include redundant check valves to control reagent flow, construction materials to  
16   withstand the reagents and pressures encountered, an eyewash, and safety shower. Reagent  
17   injection to the subsurface is conducted via specially designed mixing heads that are  
18   attached to the riser pipe of the injector (see Figure 3-4). The mixing heads are designed  
19   with redundant safety features including check valves, pressure gauges, and flow-control  
20   ball valves. They are constructed of stainless steel to withstand the reagents.

21   The entire system, from the peroxide tanker to the mobile treatment unit, as well as from  
22   the mobile treatment unit to the injector head, is entirely closed and there is no exposure to  
23   the hydrogen peroxide. The entire system is leak-checked prior to operation. Procedures to  
24   address spills are provided in the Site-Specific Health and Safety Plan. In summary, in the  
25   event of a small spill (tens of gallons or less), the spill is addressed by spraying the area  
26   with water until the hydrogen peroxide is diluted. In the event of a catastrophic spill (such  
27   as from a tank truck failure), the area must be evacuated, local fire department authorities  
28   notified, and a 24-hour GCI Emergency Hotline is available at (609) 924-6677 through the  
29   manufacturer of the hydrogen peroxide, FMC.

## 3.6 Injector Installation

### 3.6.1 Utility Clearance

The location of known utilities will be identified by CH2M -Jones before the injectors are installed. Injector locations that are near the identified underground utilities will be initially dug with a posthole digger to a depth of at least 4 ft bls to ensure that the drilling location is clear.

### 3.6.2 Injector Construction

Example construction details for injectors are provided in Figure 3-5. Injectors are constructed of materials intended to withstand elevated temperatures and pressures, as well as exposure to the reagents utilized during the Geo-Cleanse® Process. The injectors are constructed with 0.010-slot stainless steel screens and Schedule 80 steel riser pipe and couplings. The pipe and screen diameters are 1.25 inches. The injectors will be installed with a 3-ft screen. The relatively short screen length is intended to provide greater hydraulic control over reagent injection depths and to prevent formation of preferred reagent pathways through the formation.

The injectors are built and placed into the soil borings through the hollow stem auger. The augers will be systematically extracted as completion materials are added to ensure that materials do not bridge within the auger. The borehole with the injector will be backfilled with filter pack sand to a level approximately 1 ft above the top of the screen. If necessary, sand may be added by tremie pipe with approved water for adequate settling. Next, a 1-ft thick layer of bentonite (medium pellets or 3/8-inch chips) will be added and allowed 15 minutes to hydrate. Four gallons of approved water will be added to hydrate the bentonite if no water is present within the augers. The injectors will then be sealed to grade with a cement/bentonite grout mix. A cement/bentonite mix was selected to provide a more competent seal (important for injection) than high-solids bentonite slurry. The grout mix will be added by tremie pipe with side discharge to ensure the complete displacement of water within the augers and competent distribution. The grout is a non-shrinking mix consisting of Portland Type I cement, bentonite powder, and water in the ratio of 94 pounds Portland Type I cement (five pounds of bentonite powder and seven gallons of water). The target mixture weighs approximately 15 pounds per gallon. The grout will be allowed to settle after completion and additional grout will be added as necessary to fill the borehole. The injectors will be completed with stick-up construction. Construction details will be recorded on the soil boring log maintained for each boring (see Figure 3-6).

## 3.7 Performance and Process Monitoring

Performance monitoring is defined as groundwater samples collected to characterize groundwater for base-line sampling, as well as monitoring after treatment phases. Performance groundwater samples will be collected after seven and 30 days. Should an additional polishing phase be required, performance sampling will also be performed at the same time intervals. All performance monitoring will be completed by CH2M-Jones.

Field procedures and groundwater analyses will follow standard procedures found in the approved CSAP portion of the RFI Work Plan (EnSafe/Allen & Hoshall, 1994). The CSAP outlines all monitoring procedures to be performed during the investigation in order to characterize the environmental setting, source, and releases of hazardous constituents. In addition, the CSAP includes the Quality Assurance Plan (QAP) and Data Management Plan (DMP) to verify that all information and data are valid and properly documented. Unless otherwise noted, the sampling strategy and procedures will be performed in accordance with the U.S. Environmental Protection Agency (EPA) Environmental Services Division *Standard Operating Procedures and Quality Assurance Manual* (ESDSOPQAM) (1996).

The groundwater samples will be sampled in accordance with the CSAP for pesticides. Pesticides will be analyzed in accordance with the EPA's SW-846 Method 8081.

Process monitoring, which will be performed by GCI, refers to analyses of groundwater and offgas samples collected within and adjacent to the treatment area, and during implementation of the in-situ chemical oxidation treatment in order to determine if appropriate geochemical conditions are established in the aquifer and whether reagents are distributed effectively. The types of analyses conducted during process monitoring are groundwater quality measurements; these processes are described Section 3.8.4 of this IM WP.

## 3.8 Treatment Program Procedures

### 3.8.1 Sequence of Events

The treatment program phases include mobilization, treatment, and demobilization. Mobilization normally requires one day of onsite activities. Tasks required for mobilization include positioning the GCI mobile treatment unit, hydrogen peroxide tanker, and generator; establishing an exclusion zone; constructing the safety shower and hydrogen peroxide transfer station; connecting the treatment unit to the water source and power

1 generator; and leak- and safety-checking all hosing and fittings. A health and safety  
2 meeting with all personnel is normally conducted on the first day.

3 Each day of injection typically begins with a tailgate health and safety meeting. Injection of  
4 catalyst and hydrogen peroxide solutions is then performed during the course of the day,  
5 with monitoring as is described in Section 3.8.4. of this IM WP. Normal workdays range  
6 from 8 to 10 hours, or during available daylight (whichever is shorter). At the end of each  
7 day, the mixing heads and lines will be returned to the mobile treatment unit and ancillary  
8 equipment secured, the hydrogen peroxide tanker will be locked, the generator or power  
9 supply will be turned off, and the site will be secured for the night.

10 Demobilization activities include clearing the site of any fluids or debris resulting from  
11 injection activities, dismantling the hydrogen peroxide transfer station and safety shower,  
12 disconnecting from water and power supplies, and securing the mobile treatment unit,  
13 hydrogen peroxide tanker, and generator. Demobilization activities typically require a half-  
14 day of onsite activities.

### 15 **3.8.2 Duration of Treatment**

16 The treatment program at SWMU 38 is anticipated to require fewer than 7 days of onsite  
17 activities, including mobilization, injection, and demobilization activities. Injector  
18 installation is anticipated to require 1 day of drilling activities. An estimated 2,000 lbs (200  
19 gallons) or less of 50-percent concentration hydrogen peroxide are anticipated for injection  
20 into each injector (50-percent concentration hydrogen peroxide is staged at the site for  
21 economic reasons, maximum injected concentration is 25 percent). The volume of catalyst  
22 solution is anticipated to be from 2 to 4 times the peroxide volume during the injection  
23 phase.

24 The conceptual locations of the injectors are provided in Figure 3-2.

25 The implementation of a polishing phase may be required if additional treatment is  
26 required to achieve the objective of reducing DDD and DDT to levels below their respective  
27 RBCs.

### 28 **3.8.3 Reagents**

29 The reagents used in the Geo-Cleanse® Process, as well as their purpose, injected  
30 concentrations, and fate, are summarized as follows:

1 **Hydrogen Peroxide**

2 50-percent technical grade, used as oxidizing agent. Injected into groundwater and soils  
3 with a maximum 25-percent concentration, with resultant concentrations to groundwater of  
4 less than 1 percent. This concentration quickly falls to less than 25 parts per million (ppm)  
5 within several hours following injection, and is typically completely consumed within 2 to 3  
6 days.

7 **Ferrous Sulfate**

8 100-ppm aqueous solution of food grade reagent, used as a catalyst. This concentration is  
9 typically diluted in groundwater to less than 10 ppm. The ferrous iron is oxidized in the  
10 subsurface to ferric iron and precipitates as an iron oxide or iron hydroxide. Ferrous sulfate  
11 may not be used if sufficient natural iron (greater than 25 milligrams per liter [mg/L]) is  
12 present in groundwater.

13 **Sulfuric Acid**

14 66° (98-percent) technical grade, diluted prior to injection in water to a pH of approximately  
15 4. This is used in the catalyst solution to inhibit oxidation of ferrous iron to ferric iron in the  
16 catalyst solution prior to injection, and to adjust pH of the groundwater to the optimal  
17 range for Fenton's reagent (<6). Groundwater pH will return to ambient background  
18 conditions within a few days of injection. This reagent may not be utilized depending upon  
19 site-specific conditions. Sulfuric acid may not be used if either the groundwater pH is  
20 already acidic (<6), or if a more stabilizing catalyst solution is desired (in which case  
21 phosphoric acid may be used). At one week and again at 30 days after the IM injection is  
22 completed, the groundwater pH will be evaluated. Based on the results of this evaluation, a  
23 neutralization phase, using potassium hydroxide (KOH), may be considered to return the  
24 groundwater to ambient conditions.

25 **Phosphoric Acid**

26 85-percent technical grade, diluted prior to injection in water to a pH of approximately 4.  
27 This is used in the catalyst solution to inhibit oxidation of ferrous iron to ferric iron in the  
28 catalyst solution prior to injection, and to adjust the pH of the groundwater to the optimal  
29 range for Fenton's reagent (<6). Groundwater pH will return to ambient background  
30 conditions within a few days of injection. This reagent may not be utilized depending upon  
31 site-specific conditions. Phosphoric acid may not be used if either the groundwater pH is  
32 already acidic (<6), or if a more reactive catalyst solution is desired (in which case sulfuric  
33 acid may be used). At one week and again at 30 days after the injection is completed, the

1 groundwater pH will be evaluated. Based on the results of this evaluation, a neutralization  
2 phase, using KOH, may be considered to return the groundwater to ambient conditions.

### 3 **Calcium Phosphate**

4 10-ppm aqueous solution of food grade reagent, used to stabilize the Fenton's reagent. This  
5 concentration is diluted in groundwater to less than 1 ppm. The calcium remains dissolved  
6 in the solution and the phosphate is either precipitated or is utilized as a nutrient in  
7 biological reactions. This reagent may not be utilized depending upon site-specific  
8 conditions. Calcium phosphate may be used if additional phosphate is desired for  
9 stabilization, without additional acidity.

## 10 **3.8.4 Process Monitoring Parameters**

11 As part of the process monitoring, GCI will collect field measurements during the injection  
12 to ensure that the appropriate subsurface conditions exist for Fenton's reagent, that an  
13 efficient reaction is occurring, and to monitor the reaction progress. Parameters that are  
14 monitored include both groundwater quality and liberated gas measurements (i.e., carbon  
15 dioxide and oxygen). At least one groundwater sampling event will be conducted each day,  
16 including one in the morning prior to beginning the injection and one in the afternoon prior  
17 to concluding the injection. Gas measurements will be conducted at approximately two-  
18 hour intervals throughout the day using appropriate calibrated field meters, as described  
19 below. Monitoring will be performed only in the active treatment area and in the breathing  
20 zone as part of the Health and Safety Plan (i.e., the entire site is not monitored during every  
21 sampling event). Additional analyses may be performed as dictated by site conditions, but  
22 not at prescribed time intervals. Parameters that are monitored, their purpose, method,  
23 resolution, and range are as follows:

### 24 **pH**

25 Groundwater pH is monitored to ensure that appropriate pH conditions (pH <6) are  
26 established. A Hach test kit model 17-F is used. The test is a colorimetric method using  
27 bromothymol blue as an indicator. The range is 5.5 to 8.5, with resolution of  $\pm 0.1$  units. The  
28 pH measurements may be supplemented with test strips (0 to 6 with resolution of  $\pm 0.5$   
29 units) if necessary. A pH meter is not used because the electrodes are damaged by the  
30 presence of hydrogen peroxide.

### 31 **Alkalinity**

32 Alkalinity affects Fenton's reagent treatment because dissolved bicarbonate (the  
33 predominant component of groundwater alkalinity) is an efficient hydroxyl free radical

1 scavenger. A target value of <100 mg/L is desired. Alkalinity is also related to pH, because  
2 groundwater pH controls bicarbonate equilibrium and the capacity of the groundwater to  
3 contain bicarbonate. A Hach test kit model AL-AP/MG-L is used. The test is a titration  
4 method using a sulfuric acid reagent. The range is 0 to 100 mg/L (as CaCO<sub>3</sub>) with resolution  
5 of ±5 mg/L, or 20 to 400 mg/L with resolution of ±20 mg/L. This is typically collected at  
6 the beginning and end of the program.

### 7 **Dissolved Iron**

8 Dissolved iron (either as ferrous or ferric forms) is a catalyst for Fenton's reagent. A  
9 minimum of 10 mg/L is desired in groundwater, and dissolved iron monitoring determines  
10 if ferrous sulfate is used in the catalyst blend. A Hach test kit model IR-18B is used to  
11 measure both forms of iron. The test is a colorimetric method using phenanthroline reagent.  
12 The range is 0 to 10 mg/L with resolution of ±0.2 mg/L.

### 13 **Hydrogen Peroxide**

14 Hydrogen peroxide is monitored to ensure that reagents are distributed throughout the  
15 treatment area. Hydrogen peroxide is measured with Merckoquant colorimetric test strips  
16 (E.M. Science, Gibbstown, NJ) with a measurable range of 0 to 100 mg/L. The test strips  
17 have indicators labeled at 0, 1, 3, 10, 30, and 100 mg/L peroxide, and intermediate  
18 concentrations can be interpolated.

### 19 **Carbon Dioxide**

20 The oxidation of organic compounds yields carbon dioxide, which is liberated from the  
21 subsurface through adjacent injectors and monitoring wells. At sites with significant  
22 contamination, carbon dioxide production is a sensitive measure of the efficiency and  
23 progress of the treatment. At sites impacted by low levels of chlorinated aromatics such as  
24 DDD at SWMU 38, carbon dioxide production will likely not be measurable. However, GCI  
25 will collect carbon dioxide measurements as part of the treatment monitoring at SWMU 38.  
26 Carbon dioxide concentration is measured in headspaces of injectors and monitoring wells  
27 within and adjacent to the treatment area. The measurement is performed with a GasTech  
28 GT series carbon dioxide/oxygen meter. The meter uses a non-dispersive infrared  
29 absorbance detection method. Resolution is ±0.1 percent and range is 0 to 20 percent.

### 30 **Oxygen**

31 Reaction of hydroxyl free radicals with hydrogen peroxide, other radicals, or other non-  
32 organic compounds produces oxygen. Oxygen is generally liberated from the subsurface  
33 through adjacent injectors and monitoring wells. As a result of the small volume of  
34 hydrogen peroxide to be injected at SWMU 38, oxygen readings may not change

1 significantly during the treatment process. However, GCI will collect oxygen measurements  
2 as part of the treatment monitoring at SWMU 38. Oxygen concentration is measured in  
3 headspaces of injectors and monitoring wells within and adjacent to the treatment area. The  
4 measurement is performed with a GasTech GT series carbon dioxide/oxygen meter. The  
5 meter uses an electrochemical detection method. Resolution is  $\pm 0.1$  percent and range is 0 to  
6 30 percent

## 7 **3.9 Reporting**

8 An IM Completion Report will be provided 45 days after the final performance samples are  
9 reported from the laboratory.

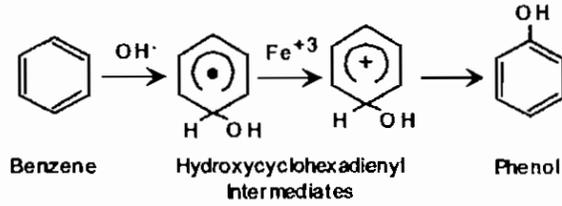
## 10 **3.10 Permitting**

### 11 **3.10.1 SCDHEC Underground Injection Control Permit Application**

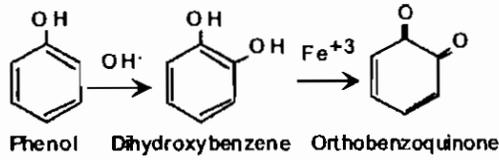
12 An Underground Injection Control Permit will be approved prior to the initiation of field  
13 work.

# Benzene Oxidation Pathway

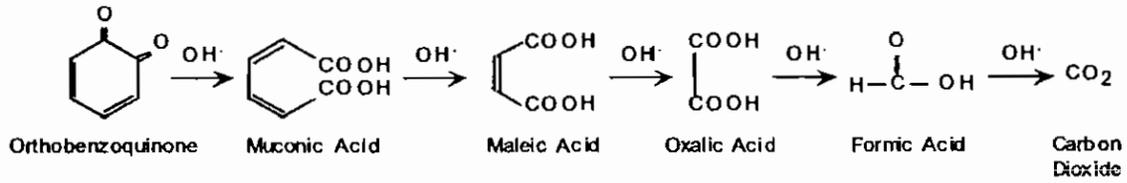
## Step 1. Benzene Hydroxylation to Phenol



## Step 2. Phenol Oxidation to Benzoquinone



## Step 3. Carboxylic Acid Formation and Oxidation to Carbon Dioxide

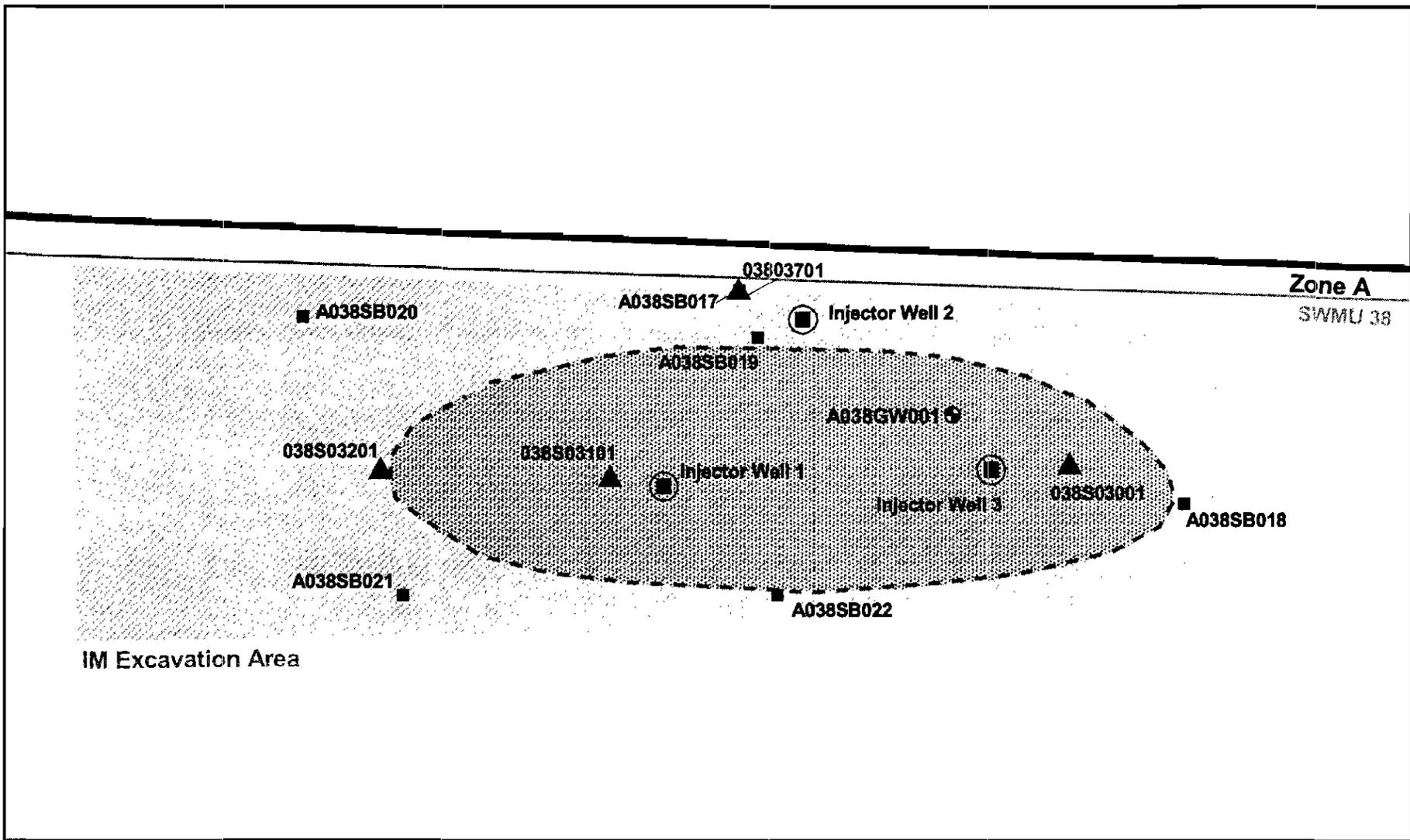


References: Walling, 1975; Edwards and Curci 1992; Scheck and Frimmel 1995.

**EXAMPLE AROMATIC COMPOUND (BENZENE)  
FENTON'S REAGENT OXIDATION PATHWAY**

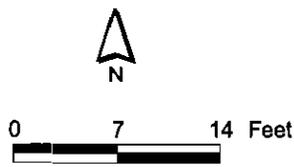
**Geo-Cleanse International, Inc.**  
4 Mark Road, Suite C  
Kenilworth, NJ 07033

FIGURE 3-1



- Injector Wells
- ▲ DET IM Confirmation Samples
- ⊕ Groundwater Well
- Subsurface Soil Samples
- ▨ Target Treatment Area

- ▨ IM Excavation Area
- SWMU Boundary
- Buildings
- ▬ Zone Boundary



**Figure 3-2**  
 Injector Locations  
 SWMU 38, Zone A  
 Charleston Naval Complex



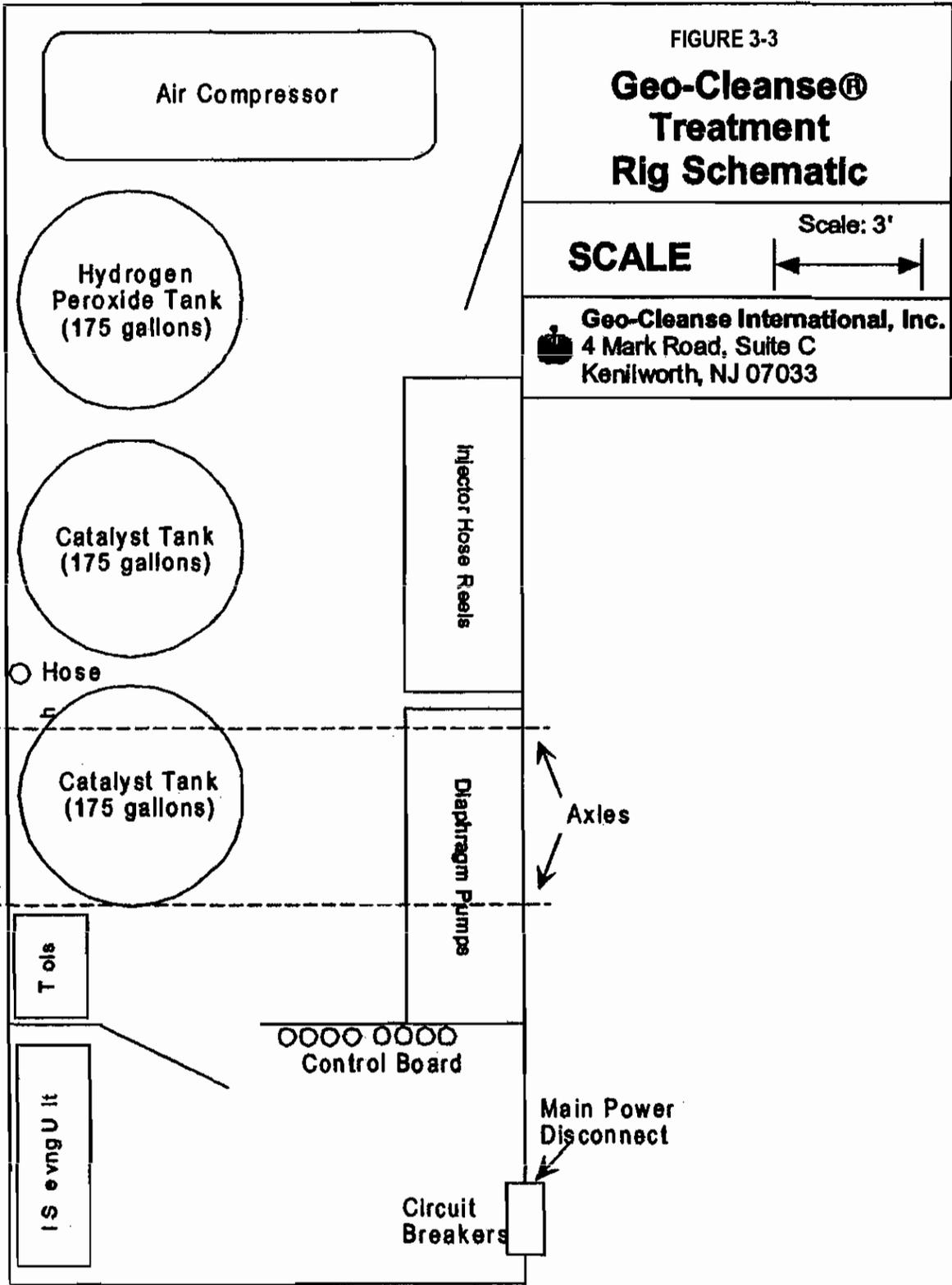


FIGURE 3-3

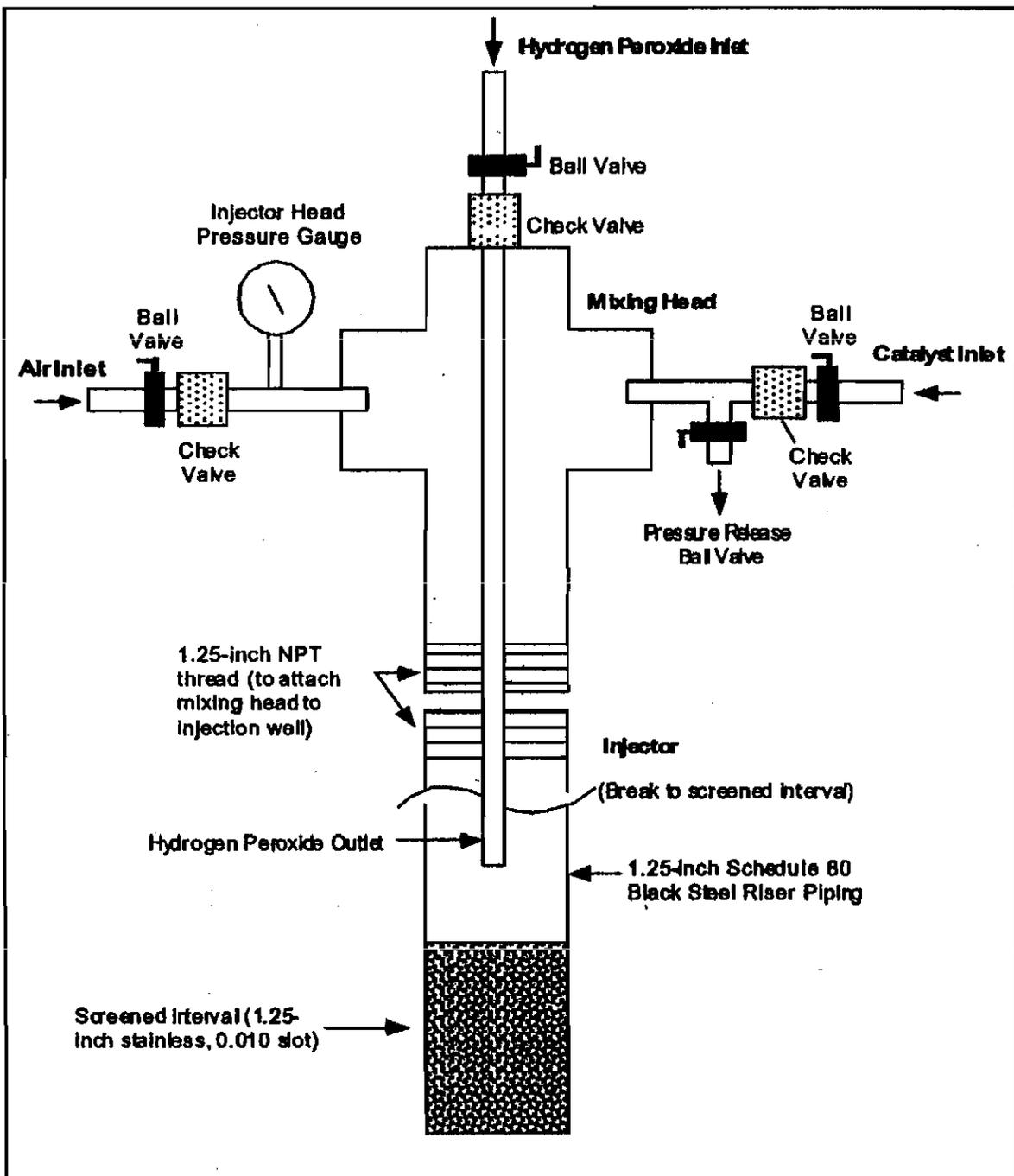
**Geo-Cleanse®  
Treatment  
Rig Schematic**

**SCALE**

Scale: 3'

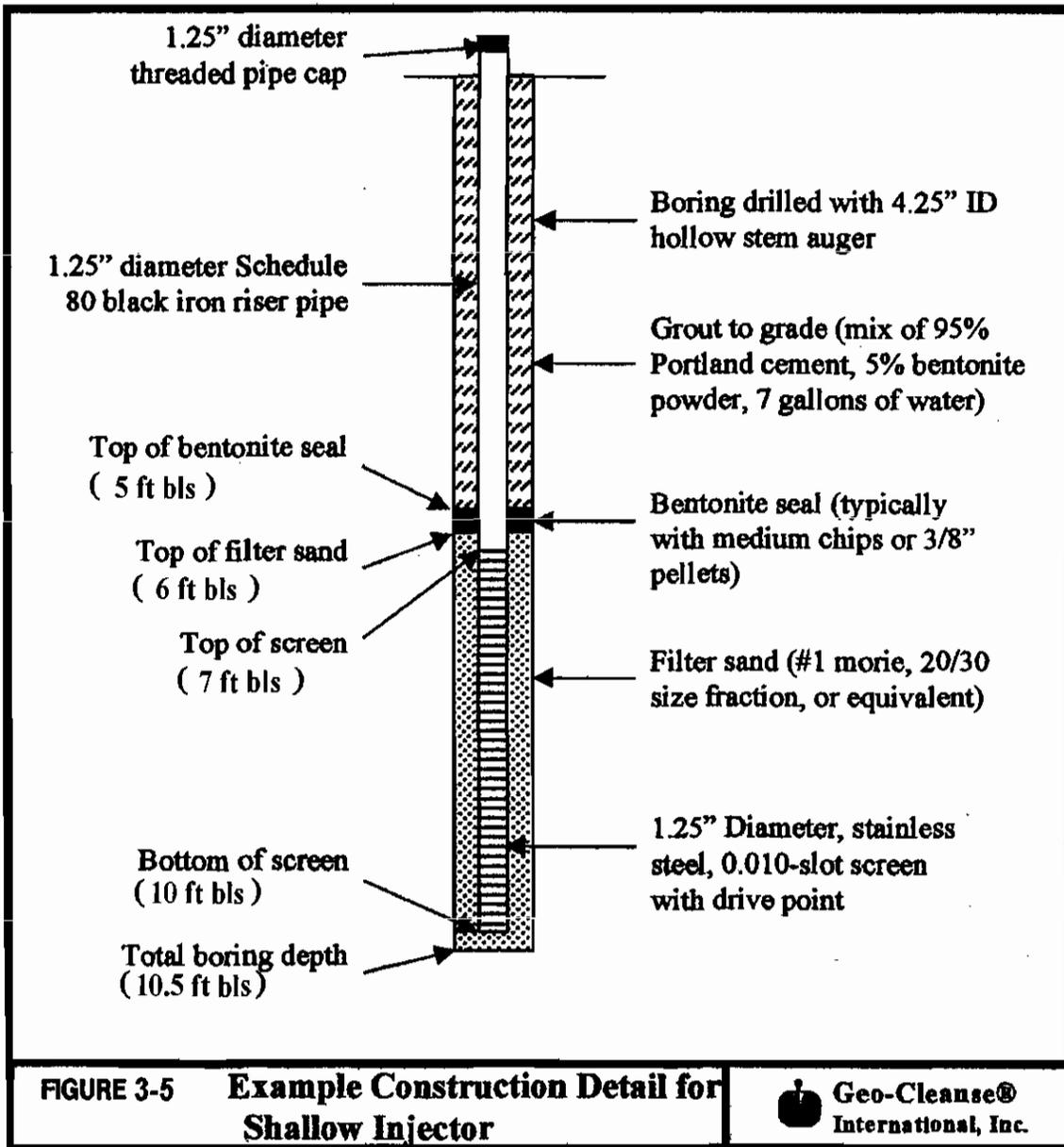


**Geo-Cleanse International, Inc.**  
4 Mark Road, Suite C  
Kenilworth, NJ 07033



**FIGURE 3-4 . Geo-Cleanse® Patented Injector and Mixing Head Design Schematic (U.S. Patents 5,525,008 and 5,611,642)**

**Geo-Cleanse International, Inc.**  
 4 Mark Road, Suite C  
 Kenilworth, NJ 07033



E122001014GNV



**Section 4.0**

---

## 1 **4.0 Investigation-Derived Waste**

---

2 IDW that is generated during this effort will include purge water from the groundwater  
3 sampling activities and well installation, soil cuttings from well installation, and personal  
4 protective equipment (PPE). IDW will be collected in labeled 55-gallon drums or portable  
5 tank for proper handling. Contained IDW will remain on site temporarily until transported  
6 to the less than 90-day storage facility located at Building 1824. Once the analytical results  
7 have been reviewed, the 55-gallon drums or portable tank containing the groundwater  
8 contents will be transported, as required, to a permitted and licensed facility for treatment  
9 or disposal.

**Section 5.0**

---

## 1 **5.0 Future Site Activities**

---

- 2 After completion of the IM, including performance monitoring, the results of the IM will be  
3 provided to SCDHEC.
- 4 If the results indicate that the IM was successful, a recommendation for no further action  
5 (NFA) for groundwater will be provided. If the results indicate that the IM was  
6 unsuccessful, a recommendation for a CMS will be provided. Additionally, the results of  
7 additional surface soil sampling for PCBs will be discussed.

**Section 6.0**

---

## 1 6.0 References

---

- 2 CH2M-Jones. *Corrective Measures Study Work Plan - Source Area Delineation for SWMU 38,*  
3 *Zone A.* Charleston Naval Complex, North Charleston, South Carolina. February 2001.
- 4 Bryant, J.D., and Wilson, J.T. Rapid delivery system completes oxidation picture. *Soil &*  
5 *Groundwater Cleanup*, August-September 1998, p.6-11. 1998.
- 6 Buxton, G. V., Greenstock, C. L., Helman, W. P., and Ross, A. B. Critical review of rate  
7 constants for reactions of hydrated electrons, hydrogen atoms and hydroxyl radicals  
8 ( $\cdot\text{OH}/\cdot\text{O}$ ) in aqueous solution. *Journal of Physical and Chemical Reference Data*, v. 17, pp. 513-  
9 886. 1988.
- 10 Chen, R. and Pignatello, J.J. Role of Quinone Intermediates as Electron Shuttles in Fenton  
11 Shuttles in Fenton and Photoassisted Fenton Oxidations of Aromatic Compounds.  
12 *Environmental Science & Technology*, v. 31, pp.2399-2406. 1997.
- 13 DET. *Completion Report, Interim Measure for SWMU 38*, Supervisor of Shipbuilding,  
14 Conversion and Repair, USN, (SUPSHIP). October 29, 1998.
- 15 EnSafe, Inc. / Allen & Hoshall. *Final Comprehensive Corrective Action Management Plan.* August  
16 30, 1994.
- 17 EnSafe/Allen & Hoshall. *Final Comprehensive Sampling and Analysis Plan.* RCRA Facility  
18 Investigation. July 30, 1996.
- 19 EnSafe, Inc. *Zone A RCRA Facility Investigation Report.* Volume II of V, Section 10.3. August  
20 7, 1998.
- 21 Haag, W. W. R., Yao, C. C. D. Rate constants for reaction of hydroxyl radicals with several  
22 drinking water contaminants. *Environmental Science and Technology*, v. 26, pp. 1005-1013.  
23 1992.
- 24 Karpel vel Leitner, N., and Doré, M. Mecanisme d'action des radicaux  $\text{OH}\cdot$  sur les acides  
25 glycolique, glyoxylique, acetique et oxalique en solution aqueuse: Incidence sur la  
26 consommation de peroxyde d'hydrogene dans les systemes  $\text{H}_2\text{O}_2/\text{UV}$  et  $\text{O}_3/\text{H}_2\text{O}_2$ . *Water*  
27 *Research*, v. 31, pp. 1383-1397. 1997.
- 28 Lindsay Smith, J. R., and Norman, R. O. C. Hydroxylation. Part I. The oxidation of benzene  
29 and toluene by Fenton's reagent. *Journal of the Chemical Society*, v. 1963, pp. 2897-2905. 1963.

- 1 Lindsey, M. E., and Tarr, M. A. Inhibition of hydroxyl radical reaction with aromatics by  
2 dissolved natural organic matter. *Environmental Science & Technology*, v. 34, pp. 444-449.  
3 2000.
- 4 Martens, D.A., and Frankenburger, W.T. Enhanced Degradation of Polycyclic Aromatic  
5 Hydrocarbons in Soil Treated with an Advanced Oxidative Process – Fenton’s Reagent.  
6 *Journal of Soil Contamination*. v. 4, pp 175-190. 1995.
- 7 Merz, J. H., and Waters, W. A. The oxidation of aromatic compounds by means of the free  
8 hydroxyl radical. *Journal of the Chemical Society*, v. 1949, pp. 2427-2433. 1949.
- 9 Scheck, C. K., and Frimmel, F. H. Degradation of phenol and salicylic acid by ultraviolet  
10 radiation/hydrogen peroxide/oxygen. *Water Research*, v. 29, pp. 2346-2352. 1995.
- 11 Sedlak, D. L., and Andren, A. W. Oxidation of chlorobenzene with Fenton’s reagent.  
12 *Environmental Science & Technology*, v. 25, p. 777-782. 1991.
- 13 U.S. Environmental Protection Agency (EPA). Advance Notice of Proposed Rulemaking (61  
14 CFR 19432, May 1).
- 15 U.S. Environmental Protection Agency (EPA). *Environmental Investigations Standard*  
16 *Operating Procedures and Quality Assurance Manual*. Region IV, Environmental Services  
17 Division. 1996.
- 18 U.S. Army Corps of Engineers (USACE). Personal correspondence between David  
19 Lane/CH2M HILL and Debbie King/USACE, Charleston District. September 14, 2000.
- 20 Walling, C., and Johnson, R. A. Fenton’s reagent. V. Hydroxylation and side-chain cleavage  
21 of aromatics. *Journal of the American Chemical Society*, v. 97, pp. 363-367. 1975.
- 22 Watts, R. J., Bottenberg, B. C., Hess, T. F., Jensen, M. D., and Teel, A. L. Role of reductants in  
23 the enhanced desorption and transformation of chloroaliphatic compounds by modified  
24 Fenton’s reactions. *Environmental Science and Technology*, v. 33, pp. 3432-3437. 1999.

Appendix A

---



# Well Number: A038GW001

Sheet: 1 of 1

Client: Navy  
 Project: CNC  
 Location: North Charleston, South Carolina  
 Project Number: 158814

Driller:  
 Drilling Method: Geoprobe  
 Sampling Method:  
 Logged by: Darryl Gates  
 Start/Finish Date: 9/24/2001

Depth Below Surface (ft)	Soil Log	Soil Description	Depth / Elev	Well Diagram	Well Construction Notes
0		Ground Surface	8		
		ROC	9		
		Sand (brown)	1		
5					
		Rock Gravel	2 6		
		Sand (tan)	1 7		
10					
		End of Log	-4 12		
15					
20					

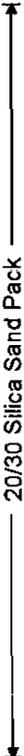
0.010" Screen



◀ Bentonite Seal



20/30 Silica Sand Pack



2" Sch 40 PVC Well Casing

4" GeoProbe Boring Diameter

Appendix B

---

Analytical Data Summary

12/10/2001 4:17 PM

	StationID	A038SB017	A038SB017	A038SB018	A038SB018
	SampleID	038SB01701 (0-1ft)	038SB01701DL (-ft)	038SB01804 (4-4.5ft)	038SB01806 (5.5-6ft)
	DateCollected	9/27/01 1:45 PM	9/27/01 12:00 AM	10/9/01 10:20 AM	10/9/01 12:00 AM
	DateAnalyzed	10/03/2001	10/05/2001	10/15/2001	10/15/2001
	SDGNumber	CNC34	CNC34	CNC39	CNC39
Parameter	Units				
Alpha BHC (Alpha Hexachlorocyclohexane)	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
Alpha-chlordane	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
Beta BHC (Beta Hexachlorocyclohexane)	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
Chlordane	mg/kg	0.015 U	0.15 R	0.015 U	0.016 U
Delta BHC (Delta Hexachlorocyclohexane)	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
Dieldrin	mg/kg	0.00073 J	0.029 R	0.0029 U	0.003 U
Endosulfan I	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
Endosulfan II	mg/kg	0.0029 U	0.029 R	0.0029 U	0.003 U
Endosulfan Sulfate	mg/kg	0.0029 U	0.029 R	0.0029 U	0.003 U
Endrin Aldehyde	mg/kg	0.0029 U	0.029 R	0.0029 U	0.003 U
Endrin Ketone	mg/kg	0.0029 U	0.029 R	0.0029 U	0.003 U
Endrin	mg/kg	0.0029 U	0.029 R	0.0029 U	0.003 U
Gamma BHC (Lindane)	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
Gamma-chlordane	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
Heptachlor Epoxide	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
Methoxychlor	mg/kg	0.015 U	0.15 R	0.015 U	0.016 U
p,p'-DDD	mg/kg	0.085 R	0.12 =	0.0016 J	0.00057 J
p,p'-DDE	mg/kg	0.12 R	0.11 =	0.0029 U	0.003 U
p,p'-DDT	mg/kg	0.6 R	0.64 =	0.0029 U	0.003 U
Toxaphene	mg/kg	0.098 U	0.98 R	0.098 U	0.1 U
Heptachlor	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
Aldrin	mg/kg	0.0015 U	0.015 R	0.0015 U	0.0016 U
2,4,5,6-Tetrachloro-meta-xylene	%PERCENT		0		
Decachlorobiphenyl	%PERCENT		0		

Analytical Data Summary

12/10/2001 4:17 PM

	StationID	A038SB019	A038SB019	A038SB020	A038SB020
	SampleID	038SB01904 (4-4.5ft)	038SB01906 (5.5-6ft)	038SB02004 (4-4.5ft)	038SB02006 (5.5-6ft)
	DateCollected	10/9/01 10:10 AM	10/9/01 12:00 AM	10/9/01 9:55 AM	10/9/01 12:00 AM
	DateAnalyzed	10/15/2001	10/15/2001	10/15/2001	10/15/2001
	SDGNumber	CNC39	CNC39	CNC39	CNC39
Parameter	Units				
Alpha BHC (Alpha Hexachlorocyclohexane)	mg/kg	0.0015 U	0.0016 U	0.0016 U	0.0016 U
Alpha-chlordane	mg/kg	0.0015 U	0.0016 U	0.0016 U	0.0016 U
Beta BHC (Beta Hexachlorocyclohexane)	mg/kg	0.0015 U	0.0016 U	0.0016 U	0.0016 U
Chlordane	mg/kg	0.015 U	0.016 U	0.016 U	0.016 U
Delta BHC (Delta Hexachlorocyclohexane)	mg/kg	0.0015 U	0.0016 U	0.0016 U	0.0016 U
Dieldrin	mg/kg	0.003 U	0.0031 U	0.003 U	0.0031 U
Endosulfan I	mg/kg	0.0015 U	0.0016 U	0.0016 U	0.0016 U
Endosulfan II	mg/kg	0.003 U	0.0031 U	0.003 U	0.0031 U
Endosulfan Sulfate	mg/kg	0.003 U	0.0031 U	0.003 U	0.0031 U
Endrin Aldehyde	mg/kg	0.003 U	0.0031 U	0.003 U	0.0031 U
Endrin Ketone	mg/kg	0.003 U	0.0031 U	0.003 U	0.0031 U
Endrin	mg/kg	0.003 U	0.0031 U	0.003 U	0.0031 U
Gamma BHC (Lindane)	mg/kg	0.0015 UJ	0.0016 U	0.0016 U	0.0016 U
Gamma-chlordane	mg/kg	0.0015 U	0.0016 U	0.0016 U	0.0016 U
Heptachlor Epoxide	mg/kg	0.0015 U	0.0016 U	0.0016 U	0.0016 U
Methoxychlor	mg/kg	0.015 U	0.016 U	0.016 U	0.016 U
p,p'-DDD	mg/kg	0.0014 J	0.0031 U	0.003 U	0.0031 U
p,p'-DDE	mg/kg	0.003 U	0.0031 U	0.003 U	0.0031 U
p,p'-DDT	mg/kg	0.003 U	0.0031 U	0.003 U	0.0031 U
Toxaphene	mg/kg	0.099 U	0.1 U	0.1 U	0.1 U
Heptachlor	mg/kg	0.0015 U	0.0016 U	0.0016 U	0.0016 U
Aldrin	mg/kg	0.0015 U	0.0016 U	0.0016 U	0.0016 U
2,4,5,6-Tetrachloro-meta-xylene	PERCENT				
Decachlorobiphenyl	PERCENT				

Analytical Data Summary

12/10/2001 4:17 PM

	StationID	A038SB021	A038SB021	A038SB022	A038SB022
	SampleID	038SB02104 (4-4.5ft)	038SB02106 (5.5-6ft)	038SB02203 (-ft)	038SB02204 (-ft)
	DateCollected	10/9/01 9:35 AM	10/9/01 12:00 AM	10/9/01 9:20 AM	10/9/01 9:25 AM
	DateAnalyzed	10/15/2001	10/15/2001	10/15/2001	10/16/2001
	SDGNumber	CNC39	CNC39	CNC39	CNC39
Parameter	Units				
Alpha BHC (Alpha Hexachlorocyclohexane)	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.00023 J
Alpha-chlordane	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.0016 UJ
Beta BHC (Beta Hexachlorocyclohexane)	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.0016 U
Chlordane	mg/kg	0.016 U	0.015 U	0.016 U	0.016 U
Delta BHC (Delta Hexachlorocyclohexane)	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.0016 U
Dieldrin	mg/kg	0.003 U	0.003 U	0.003 U	0.003 U
Endosulfan I	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.0016 U
Endosulfan II	mg/kg	0.003 U	0.003 U	0.003 U	0.003 UJ
Endosulfan Sulfate	mg/kg	0.003 U	0.003 U	0.003 U	0.003 U
Endrin Aldehyde	mg/kg	0.003 U	0.003 U	0.003 U	0.003 U
Endrin Ketone	mg/kg	0.003 U	0.003 U	0.003 U	0.003 U
Endrin	mg/kg	0.003 U	0.003 U	0.003 U	0.003 U
Gamma BHC (Lindane)	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.0016 U
Gamma-chlordane	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.0016 UJ
Heptachlor Epoxide	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.0016 UJ
Methoxychlor	mg/kg	0.016 U	0.015 U	0.016 U	0.016 UJ
p,p'-DDD	mg/kg	0.00049 J	0.003 U	0.0012 J	0.001 J
p,p'-DDE	mg/kg	0.003 U	0.003 U	0.003 U	0.003 U
p,p'-DDT	mg/kg	0.003 U	0.003 U	0.0015 J	0.003 U
Toxaphene	mg/kg	0.1 U	0.099 U	0.1 U	0.1 U
Heptachlor	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.0016 U
Aldrin	mg/kg	0.0016 U	0.0015 U	0.0016 U	0.0016 U
2,4,5,6-Tetrachloro-meta-xylene	%PERCENT				
Decachlorobiphenyl	%PERCENT				

Analytical Data Summary

12/10/2001 4:17 PM

	StationID	A038GW001	A038GW001
	SampleID	038GW001L1	038GW001L1RE
	DateCollected	9/27/01 11:05 AM	9/27/01 12:00 AM
	DateAnalyzed	10/03/2001	10/05/2001
	SDGNumber	CNC34	CNC34
Parameter	Units		
Chlordane	ug/l	0.4 R	0.4 U
Alpha BHC (Alpha Hexachlorocyclohexane)	ug/l	0.04 R	0.04 U
Gamma BHC (Lindane)	ug/l	0.04 R	0.04 U
Beta BHC (Beta Hexachlorocyclohexane)	ug/l	0.04 R	0.04 U
Heptachlor	ug/l	0.04 R	0.04 U
Delta BHC (Delta Hexachlorocyclohexane)	ug/l	0.04 R	0.04 U
Aldrin	ug/l	0.04 R	0.04 U
Heptachlor Epoxide	ug/l	0.04 R	0.04 U
Gamma-chlordane	ug/l	0.04 R	0.04 U
Alpha-chlordane	ug/l	0.04 R	0.04 U
Endosulfan I	ug/l	0.04 R	0.04 U
p,p'-DDE	ug/l	0.08 R	0.08 U
Dieldrin	ug/l	0.08 R	0.08 U
Endrin	ug/l	0.08 R	0.08 U
p,p'-DDD	ug/l	1 R	0.97 =
Endosulfan II	ug/l	0.08 R	0.08 U
p,p'-DDT	ug/l	0.08 R	0.08 U
Endrin Aldehyde	ug/l	0.08 R	0.08 U
Endosulfan Sulfate	ug/l	0.08 R	0.08 U
Methoxychlor	ug/l	0.38 R	0.38 UJ
Endrin Ketone	ug/l	0.08 R	0.08 U
Toxaphene	ug/l	2.5 R	2.5 U
2,4,5,6-Tetrachloro-meta-xylene	%PERCENT		58
Decachlorobiphenyl	%PERCENT		60

Appendix C

---

## Data Validation Summary - Charleston Naval Complex - Zone A, SWMU 38

TO: Jim Edens/CH2M HILL/GNA

FROM: Amy Juchem/CH2M HILL/GNA  
Herb Kelly/CH2M HILL/GNA

DATE: November 15, 2001

The purpose of this memorandum is to present the results of the data validation process for the samples collected in Zone A, SWMU 38. The samples were collected between the dates of September 27 and October 9, 2001.

The specific samples and analytical fractions reviewed are summarized below in Table 1.

The Quality Control areas that were review and the resulting findings are documented within each subsection that follows. This data was validated for compliance with the analytical method requirements. This process also included a review of the data to assess the accuracy, precision, and completeness based upon procedures described in the guidance documents such as the Environmental Protection Agency (EPA) *National Functional Guidelines for Inorganic Data Review* (EPA 1994) and *National Functional Guidelines for Organic Data Review* (EPA 1999). Quality assurance/quality control (QA/QC) summary forms and data reports were reviewed.

Samples were submitted to Severn Trent Services, STL Savannah Laboratories, Inc., in Savannah, Georgia for SW-846 8081 Organochlorine Pesticides and SW-846 8082 Polychlorinated Biphenyls (PCBs).

Sample results that were not within the acceptance limits were appended with a qualifying flag, which consisted of a single- or double-letter code that indicated a possible problem with the data. The qualifying flags originated during the data review and validation processes. These also include the secondary, or the two-digit "sub-qualifier" flags. The secondary qualifiers provide the reasoning behind the assignment of a qualifier flag to the data. The secondary qualifiers are presented and defined below.

Attachment 1 lists the changes in data qualifiers, due to the validation process.

The following primary flags were used to qualify the data:

- [=] Detected. The analyte was analyzed for and detected at the concentration shown.
- [J] Estimated. The analyte was present but the reported value may not be accurate or precise.
- [U] Undetected. The analyte was analyzed for but not detected above the method detection limit.
- [UJ] Detection limit estimated. The analyte was analyzed for but qualified as not detected; the result is estimated.
- [R] Rejected. The data is not useable.

### Secondary Data Validation Qualifiers

Code	Definition
2S	Second Source
BL	Blank
BD	Blank Spike/Blank Spike Duplicate or (LCS/LCSD) Precision
BS	Blank Spike/LCS
CC	Continuing Calibration Verification
DL	Dilution
FD	Field Duplicate
HT	Holding Time
IB	In-Between (metals - B's → J's )
IC	Initial Calibration
IS	Internal Standard
LD	Lab Duplicate
LR	Concentration exceeded Linear Range
MD	MS/MSD or LCS/LCSD Precision
MS	Matrix Spike/Matrix Spike Duplicate
OT	Other (see DV worksheet)
PD	Pesticide Degradation
PS	Post Spike
RE	Re-extraction/Re-analysis
SD	Serial Dilution
SS	Spiked Surrogate
TN	Tune

**Table 1 - Chemical Analytical Methods – Field and Quality Control Samples**

Site	Station ID	Sample ID	Date Collected	Matrix	Analysis Code	Sample Type	Field Duplicate	Lab Duplicate
CNC33	A038SB015	038SB01501	09/27/01	SO	S116351*1	N		X
CNC33	A038SB016	038CB01601	09/27/01	SO	S116351*3	FD		X
CNC33	A038SB016	038SB01601	09/27/01	SO	S116351*2	N		X
CNC33	FIELDQC	038EB015L1	09/27/01	SQ	S116351*4	EB		X
CNC34	A038GW001	038EW001L1	09/27/01	WQ	S116351A*4	EB	X	
CNC34	A038GW001	038EW001L1RE	09/27/01	WQ	S116351A*4*RE	EB	X	
CNC34	A038GW001	038GW001L1	09/27/01	WG	S116351A*3	N	X	
CNC34	A038GW001	038GW001L1RE	09/27/01	WG	S116351A*3*RE	LR	X	
CNC34	A038SB017	038SB01701	09/27/01	SO	S116351A*1	N	X	
CNC34	A038SB017	038SB01701DL	09/27/01	SO	S116351A*1*DL	LR	X	
CNC34	FIELDQC	038EB017L1	09/27/01	SQ	S116351A*2	EB	X	
CNC34	FIELDQC	038EB017L1RE	09/27/01	SQ	S116351A*2*RE	EB	X	
CNC39	A038SB018	038SB01804	10/09/01	SO	S116625*1	N	X	
CNC39	A038SB018	038SB01806	10/09/01	SO	S116625*2	N	X	
CNC39	A038SB019	038SB01904	10/09/01	SO	S116625*3	N	X	
CNC39	A038SB019	038SB01906	10/09/01	SO	S116625*4	N	X	
CNC39	A038SB020	038SB02004	10/09/01	SO	S116625*5	N	X	
CNC39	A038SB020	038SB02006	10/09/01	SO	S116625*6	N	X	
CNC39	A038SB021	038SB02104	10/09/01	SO	S116625*7	N	X	
CNC39	A038SB021	038SB02106	10/09/01	SO	S116625*8	N	X	
CNC39	A038SB021	038SB02106MS	10/09/01	SQ	S116625*19	MS	X	
CNC39	A038SB021	038SB02106SD	10/09/01	SQ	S116625*21	SD	X	
CNC39	A038SB022	038SB02203	10/09/01	SO	S116625*9	N	X	
CNC39	A038SB022	038SB02204	10/09/01	SO	S116625*10	N	X	
CNC39	FIELDQC	038EB017L1	09/27/01	SQ	S116625*11	EB	X	
CNC39	FIELDQC	038EB017L1RE	09/27/01	SQ	S116625*11*RE	EB	X	

**MATRIX CODE**

SO - Soil  
 SQ - Soil QC Samples  
 WG - Ground Water  
 WQ - Water QC Samples

**SAMPLE TYPE CODE**

EB - Equipment Blank  
 FD - Field Duplicate  
 N - Native Sample  
 MS - Matrix Spike  
 SD - Matrix Spike Duplicate  
 LR - Laboratory Replicate

**ANALYSIS CODE**

Pest - Pesticides  
 PCBs - Polychlorinated Biphenyls

# Organic Parameters

## Quality Control Review

The following list represents the QA/QC measures that were reviewed during the data quality evaluation procedure for organic data.

- **Holding Times** – The holding times are evaluated to verify that samples were extracted and analyzed within holding times.
- **Blank samples** – Method blanks and equipment blanks were provided for this project. Blank samples enable the reviewer to determine if an analyte may be attributed to sampling or laboratory procedures, rather than environmental contamination from site activities.
- **Surrogate Recoveries** – Surrogate Compounds are added to each sample and the recoveries are used to monitor lab performance and possible matrix interference.
- **Lab Control Sample (LCS)** – This sample is a "controlled matrix", either laboratory reagent water or Ottawa sand, in which target compounds have been added prior to extraction/analysis. The recoveries serve as a monitor of the overall performance of each step during the analysis, including sample preparation.
- **Field Duplicate Samples** – These samples are collected to determine precision between a native and its duplicate. This information can only be determined when target compounds are detected.
- **Matrix Spike/Matrix Spike Duplicate (MS/MSD) Samples** – Spike recovery is used to evaluate potential matrix interferences, as well as accuracy. Precision information is also determined by calculating the reproducibility between the recoveries of each spiked parameter.
- **GC/MS Tuning** – The mass spectrum of the tuning compound is evaluated for method compliance. The criteria are established to verify the proper mass assignment and mass resolution.
- **Initial Calibration** – The initial calibration ensures that the instrument is capable of producing acceptable qualitative and quantitative data for the compounds of interest.
- **Continuing Calibration** – The continuing calibration checks satisfactory performance of the instrument and its predicted response to the target compounds.
- **Internal Standards** – The internal standards (retention time and response) are evaluated for method compliance. The internal standards are used in quantitation of the target parameters and monitor the instrument sensitivity and response for stability during each analysis.
- **Confirmation** – If GCMS methodology is not initially used for analysis, SW-846 method 8000 requires confirmation when the composition of samples is not well characterized. Therefore, even when the identification has been confirmed on a dissimilar column or detector, the agreement of the quantitative results on both columns is evaluated. For

Pesticide analyses covered in this report, confirmation was performed using a dissimilar analytical column. The laboratory analyzed samples with a gas chromatograph (GC) utilizing simultaneous primary and confirmation data acquisition. Per SW-86 method 8000, 40% RPD criteria was used as the acceptance limit.

## Organochlorine Pesticide Analyses

The QA/QC parameters for the Organochlorine Pesticide analyses by method SW-846 8081A for all of the samples were within acceptable control limits, except as noted below:

### Calibrations

All initial and continuing calibration criteria were met except as noted in Table 2 below. In addition, the second column confirmation percent difference (%D) for some detected parameters, exceeded the 40 %D criteria in selected samples. Those results were flagged "J", as estimated.

**TABLE 2**

Exceptions to Initial Calibration Criteria and Continuing Calibration Criteria: Pesticides  
Charleston Naval Complex, Zone A, SWMU38, Charleston, SC

Sample ID	Parameter	Percent Difference (%D)	Acceptance Criteria
SGMECD2 RTX-CLP2 - CCAL, 10/15/01, 22:51	Heptachlor Epoxide	23.2% low	CNC39 - 1-9, 11, 3MS/MSD
	Methoxychlor	19.1% low	
	Endrin Ketone	21.4% high	
SGMECD1 RTX-CLP - CCAL, 10/16/01, 10:54	Gamma-Chlordane	15.9% low	CNC39 - 10
	Alpha-Chlordane	20.3% low	
	Endosulfan II	18.0% low	
SGMECD2 RTX-CLP2 - CCAL, 10/16/01, 10:54	Heptachlor-Epoxide	34.6% low	CNC39 - 10
	Methoxychlor	25.5% low	
	Endrin Ketone	30.6% high	
SGMECD2 RTX-CLP2 - CCAL, 10/16/01, 18:22	Methoxychlor	19.3% low	CNC39 - 10
SGMECD1 RTX-CLP - CCAL, 10/18/01, 12:23	Heptachlor	15.6% low	CNC39 - 11re
	4,4'-DDT	18.0% low	
	Methoxychlor	34.1% low	
SGMECD2 RTX-CLP2 - CCAL, 10/18/01, 12:23	Methoxychlor	37.6% low	CNC39 - 11re
SGMECD2 RTX-CLP2 - CCAL, 10/18/01, 20:24	Methoxychlor	25.8% low	CNC39 - 11re
SGIECD1 - CCAL, 10/05/01, 10:47	Methoxychlor	21.7% low	CNC34 - 1DL, 1DL MS/MSD, 2RE, 3RE, 4RE
SGIECD2 - CCAL, 10/05/01, 10:47	Methoxychlor	21.9% low	CNC34 - 1DL, 1DL MS/MSD, 2RE, 3RE, 4RE
SGIECD2 - CCAL, 10/05/01, 20:48	Methoxychlor	22.5% low	CNC34 - 1DL, 1DL MS/MSD, 2RE, 3RE, 4RE

Flags were applied to the compounds in the associated samples in the following manner:

- When the percent difference (%D) or RRF was low in the continuing calibration standards, detected compounds were flagged "J" and non-detected compounds were flagged "UJ", as estimated.
- When the percent difference was high, detected compounds were flagged "J", as estimated. Non-detected compounds were not flagged.

**Surrogate, Matrix Spike, and Matrix Spike Duplicate Recoveries**

All surrogate, matrix spike (MS), and matrix spike duplicate (MSD) recoveries were within acceptable quality control limits, except as noted in Table 3.

Sample	Sample	Compound	Recovery	Recovery Limit	Associated Sample	Flag
CNC39	#3MS/MSD / 038SB01904	Gamma-BHC (Lindane)	38* / 42*	46-127	CNC39 - #3 / 038SB01904	Detects-J
CNC39	#1 / 038SB01804	Tetrachloro-m-xylene	26*	60-150	#1 / 038SB01804	No Flags Applied, Decachlorobiphenyl recoveries OK
	#2 / 038SB01806		28*		#2 / 038SB01806	
	#3 / 038SB01904		40*		#3 / 038SB01904	
	#4 / 038SB01906		44*		#4 / 038SB01906	
	#5 / 038SB02004		38*		#5 / 038SB02004	
	#6 / 038SB02006		45*		#6 / 038SB02006	
	#7 / 038SB02104		38*		#7 / 038SB02104	
	#8 / 038SB02106		29*		#8 / 038SB02106	
	#9 / 038SB02203		32*		#9 / 038SB02203	
	#10 / 038SB02204		40*		#10 / 038SB02204	
	#11 / 038EB017L1		34*		#11 / 038EB017L1	
	#11RE / 038EB017L1RE	48*	#11RE / 038EB017L1RE	No Flags Applied, results from first analysis used		
CNC39	#11 / 038EB017L1	Decachlorobiphenyl	19*	60-150	#11 / 038EB017L1	No Flags Applied

**TABLE 3**

Surrogate and MS/MSD Recoveries Out of QC Limits: Pesticides  
 Charleston Naval Complex, Zone A, SWMU 38, Charleston, SC

Sample ID	Sample	Parameter	Recovery (%)	Recovery Limit	Sample	Flag
	#11RE / 038EB017L1RE		30*		#11RE / 038EB017L1RE	No Flags Applied, results from first analysis used
CNC34	#1 / 038SB01701	Tetrachloro-m-xylene	44*	60-150	#2 / 038EB017L1	No Flags Applied
	#2 / 038EB017L1		48*		#2 / 038EB017L1	No Flags Applied
	#3 / 038GW001L1		32*		#3 / 038GW001L1	No Flags Applied
	#4 / 038EW001L1		52*		#4 / 038EW001L1	Detects-J, non-detects-UJ
	#2RE / 038EB017L1RE		54*		#2RE / 038EB017L1RE	No Flags Applied, results from first analysis used
	#3RE / 038GW001L1RE		58*		#3RE / 038GW001L1RE	
	#4RE / 038EW001L1RE		42*		#4RE / 038EW001L1RE	
CNC34	#2 / 038EB017L1	Decachlorobiphenyl	38*	60-150	#2 / 038EB017L1	No Flags Applied
	#3 / 038GW001L1		34*		#3 / 038GW001L1	No Flags Applied
	#4 / 038EW001L1		38*		#4 / 038EW001L1	Detects-J, non-detects-UJ
	#2RE / 038EB017L1RE		41*		#2RE / 038EB017L1RE	No Flags Applied, results from first analysis used
	#4RE / 038EW001L1RE		48*		#4RE / 038EW001L1RE	

\* - out of control limits

## Polychlorinated Biphenyls

The QA/QC parameters for the Polychlorinated Biphenyls analyses by method SW-846 8082 for all of the samples were within acceptable control limits, except as noted below.

### Calibrations

All initial and continuing calibration criteria were met except as noted in Table 4 below. In addition, the second column confirmation percent difference (%D) for some detected parameters, exceeded the 40 %D criteria in selected samples. Those results were flagged "J", as estimated.

Parameter/Reference Date	Matrix	Relative Standard Deviation (%RSD)	Associated Samples
SGIECD1 – CCAL, 10/02/01, 23:36	Aroclor-1260	15.8% high	CNC33 - #1-4
	Aroclor-1260 (2)	16.1% high	
SGIECD1 – CCAL, 10/03/01, 12:20	Aroclor-1260	15.9% high	CNC33 - #1-4
	Aroclor-1260 (2)	16.7% high	
	Aroclor-1260 (4)	15.7% high	
SGIECD2 – CCAL, 10/03/01, 15:50	Aroclor-1248 (5)	15.2% high	CNC33 - #1-4

Flags were applied to the compounds in the associated samples in the following manner:

- When the percent difference (%D) or RRF was low in the continuing calibration standards, detected compounds were flagged "J" and non-detected compounds were flagged "UJ", as estimated.
- When the percent difference was high, detected compounds were flagged "J", as estimated. Non-detected compounds were not flagged.

## Surrogate Recoveries

All surrogate recoveries were within acceptable quality control limits, except as noted in Table 5.

**TABLE 5**

Surrogate Recoveries Out of QC Limits: PCBs  
Charleston Naval Complex, Zone A, SWMU 38, Charleston, SC

Event	Sample	Compound	Recovery	Control Limit	QC Sample	QC Status
CNC33	#2 / 038SB01601	Tetrachloro-m-xylene	50*	60-150	#2 / 038SB01601	No Flags Applied, Decachloro-biphenyl recoveries OK
	#3 / 038CB01601		50*		#3 / 038CB01601	
	#4 / 038EB015L1		56*		#4 / 038EB015L1	
CNC33	#2 / 038SB01601	Tetrachloro-m-xylene (2 <sup>nd</sup> column)	45*	60-150	#2 / 038SB01601	No Flags Applied, Decachloro-biphenyl recoveries OK
	#3 / 038CB01601		48*		#3 / 038CB01601	
	#4 / 038EB015L1		44*		#4 / 038EB015L1	
CNC33	#4 / 038EB015L1	Decachlorobiphenyl	48*	60-150	#4 / 038EB015L1	No Flags Applied
CNC33	#4 / 038EB015L1	Decachlorobiphenyl (2 <sup>nd</sup> column)	36*	60-150	#4 / 038EB015L1	No Flags Applied

\* - out of control limits

## Rejected Data

No data was rejected for this sampling event.

## Conclusion

A review of the analytical data submitted regarding the investigation of Zone A, SWMU 38 at the Charleston Naval Complex, Charleston, South Carolina by CH2M HILL has been completed. An overall evaluation of the data indicates that the sample handling, shipment, and analytical procedures have been adequately completed, and that the analytical results should be considered usable as qualified.

The analytical data had minor QC concerns as discussed above, requiring minimal flagging. However, the validation review demonstrated that the analytical systems were generally in control and the data results can be used in the decision making process.

Attachment 1 - Changed Qualifiers and Results  
Zone A, SWMU 38 - Data Validation

SDG	Sample ID	Lab Sample ID	Matrix	Parameter Class	Analytical Method	Parameter	Lab Result	Lab Qual	Final Result	Final Qual	Units	Reasons
CNC33	038SB01501	S116351*1	SO	PCB	SW8082	PCB-1254 (AROCHLOR 1254)	2400	=	2400	J	ug/kg	2C
CNC33	038SB01501	S116351*1	SO	PCB	SW8082	PCB-1260 (AROCHLOR 1260)	840	=	840	J	ug/kg	CC
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	ENDOSULFAN I	0.044	U	0.044	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	DELTA BHC	0.044	U	0.044	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	GAMMA BHC (LINDANE)	0.044	U	0.044	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	Chlordane	0.44	U	0.44	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	ALPHA-CHLORDANE	0.044	U	0.044	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	GAMMA-CHLORDANE	0.044	U	0.044	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	p,p'-DDD	0.089	U	0.089	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	p,p'-DDE	0.089	U	0.089	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	ALPHA BHC	0.044	U	0.044	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	DIELDRIN	0.089	U	0.089	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	ALDRIN	0.044	U	0.044	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	ENDOSULFAN II	0.089	U	0.089	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	ENDOSULFAN SULFATE	0.089	U	0.089	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	ENDRIN	0.089	U	0.089	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	ENDRIN ALDEHYDE	0.089	U	0.089	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	ENDRIN KETONE	0.089	U	0.089	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	HEPTACHLOR EPOXIDE	0.044	U	0.044	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	HEPTACHLOR	0.044	U	0.044	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	METHOXYCHLOR	0.42	U	0.42	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	p,p'-DDT	0.089	U	0.089	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	TOXAPHENE	2.8	U	2.8	R	ug/l	RE
CNC34	038EB017L1RE	S116351A*2*RE	SQ	PEST	SW8081	BETA BHC	0.044	U	0.044	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	p,p'-DDD	0.08	U	0.08	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	HEPTACHLOR EPOXIDE	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	ENDRIN KETONE	0.08	U	0.08	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	ENDRIN ALDEHYDE	0.08	U	0.08	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	ENDRIN	0.08	U	0.08	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	ENDOSULFAN SULFATE	0.08	U	0.08	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	ENDOSULFAN II	0.08	U	0.08	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	ENDOSULFAN I	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	DIELDRIN	0.08	U	0.08	R	ug/l	RE

Attachment 1 - Changed Qualifiers and Results  
Zone A, SWMU 38 - Data Validation

SDG	Sample ID	Lab Sample ID	Matrix	Parameter Class	Analytical Method	Parameter	Lab Result	Lab Qual	Final Result	Final Qual	Units	Reasons
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	TOXAPHENE	2.5	U	2.5	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	p,p'-DDE	0.08	U	0.08	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	HEPTACHLOR	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	GAMMA-CHLORDANE	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	ALPHA-CHLORDANE	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	Chlordane	0.4	U	0.4	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	GAMMA BHC (LINDANE)	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	DELTA BHC	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	BETA BHC	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	ALPHA BHC	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	ALDRIN	0.04	U	0.04	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	METHOXYCHLOR	0.38	U	0.38	R	ug/l	RE
CNC34	038EW001L1RE	S116351A*4*RE	WQ	PEST	SW8081	p,p'-DDT	0.08	U	0.08	R	ug/l	RE
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	ENDOSULFAN SULFATE	0.08	U	0.08	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	DIELDRIN	0.08	U	0.08	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	ENDOSULFAN I	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	BETA BHC	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	DELTA BHC	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	GAMMA BHC (LINDANE)	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	Chlordane	0.4	U	0.4	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	ALPHA-CHLORDANE	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	GAMMA-CHLORDANE	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	p,p'-DDD	1	=	1	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	ALPHA BHC	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	p,p'-DDT	0.08	U	0.08	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	ALDRIN	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	ENDOSULFAN II	0.08	U	0.08	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	ENDRIN	0.08	U	0.08	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	ENDRIN ALDEHYDE	0.08	U	0.08	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	ENDRIN KETONE	0.08	U	0.08	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	HEPTACHLOR EPOXIDE	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	HEPTACHLOR	0.04	U	0.04	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	METHOXYCHLOR	0.38	U	0.38	R	ug/l	SS

Attachment 1 - Changed Qualifiers and Results  
Zone A, SWMU 38 - Data Validation

SDG	Sample ID	Lab Sample ID	Matrix	Parameter Class	Analytical Method	Parameter	Lab Result	Lab Qual	Final Result	Final Qual	Units	Reasons
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	TOXAPHENE	2.5	U	2.5	R	ug/l	SS
CNC34	038GW001L1	S116351A*3	WG	PEST	SW8081	p,p'-DDE	0.08	U	0.08	R	ug/l	SS
CNC34	038GW001L1RE	S116351A*3*RE	WG	PEST	SW8081	METHOXYCHLOR	0.38	U	0.38	UJ	ug/l	CC
CNC34	038SB01701	S116351A*1	SO	PEST	SW8081	p,p'-DDD	85	E	85	R	ug/kg	LR
CNC34	038SB01701	S116351A*1	SO	PEST	SW8081	p,p'-DDE	120	E	120	R	ug/kg	LR
CNC34	038SB01701	S116351A*1	SO	PEST	SW8081	p,p'-DDT	600	E	600	R	ug/kg	LR
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	GAMMA BHC (LINDANE)	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	METHOXYCHLOR	150	U	150	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	HEPTACHLOR	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	HEPTACHLOR EPOXIDE	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	ENDRIN KETONE	29	U	29	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	ENDRIN ALDEHYDE	29	U	29	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	ENDRIN	29	U	29	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	ENDOSULFAN SULFATE	29	U	29	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	ENDOSULFAN I	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	GAMMA-CHLORDANE	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	TOXAPHENE	980	U	980	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	Chlordane	150	U	150	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	ENDOSULFAN II	29	U	29	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	DELTA BHC	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	BETA BHC	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	ALPHA BHC	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	ALDRIN	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	ALPHA-CHLORDANE	15	U	15	R	ug/kg	DL
CNC34	038SB01701DL	S116351A*1*DL	SO	PEST	SW8081	DIELDRIN	29	U	29	R	ug/kg	DL
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	ENDRIN KETONE	0.08	U	0.08	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	GAMMA-CHLORDANE	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	p,p'-DDD	0.08	U	0.08	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	p,p'-DDE	0.08	U	0.08	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	p,p'-DDT	0.08	U	0.08	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	DIELDRIN	0.08	U	0.08	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	ENDOSULFAN I	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	ENDOSULFAN II	0.08	U	0.08	R	ug/l	RE

Attachment 1 - Changed Qualifiers and Results  
Zone A, SWMU 38 - Data Validation

SDG	Sample ID	Lab Sample ID	Matrix	Parameter Class	Analytical Method	Parameter	Lab Result	Lab Qual	Final Result	Final Qual	Units	Reasons
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	ENDOSULFAN SULFATE	0.08	U	0.08	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	ENDRIN ALDEHYDE	0.08	U	0.08	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	ALPHA BHC	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	DELTA BHC	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	HEPTACHLOR EPOXIDE	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	BETA BHC	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	HEPTACHLOR	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	METHOXYCHLOR	0.38	U	0.38	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	TOXAPHENE	2.5	U	2.5	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	Chlordane	0.4	U	0.4	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	GAMMA BHC (LINDANE)	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	ALDRIN	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	ALPHA-CHLORDANE	0.04	U	0.04	R	ug/l	RE
CNC39	038EB017L1RE	S116625*11*RE	SQ	PEST	SW8081	ENDRIN	0.08	U	0.08	R	ug/l	RE
CNC39	038SB01904	S116625*3	SO	PEST	SW8081	GAMMA BHC (LINDANE)	1.5	U	1.5	UJ	ug/kg	MS
CNC39	038SB02204	S116625*10	SO	PEST	SW8081	ALPHA-CHLORDANE	1.6	U	1.6	UJ	ug/kg	CC
CNC39	038SB02204	S116625*10	SO	PEST	SW8081	HEPTACHLOR EPOXIDE	1.6	U	1.6	UJ	ug/kg	CC
CNC39	038SB02204	S116625*10	SO	PEST	SW8081	METHOXYCHLOR	16	U	16	UJ	ug/kg	CC
CNC39	038SB02204	S116625*10	SO	PEST	SW8081	GAMMA-CHLORDANE	1.6	U	1.6	UJ	ug/kg	CC
CNC39	038SB02204	S116625*10	SO	PEST	SW8081	ENDOSULFAN II	3	U	3	UJ	ug/kg	CC