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**ENVIRONMENTAL
RESTORATION
PROGRAM**

**Treatability Study for WAG 6
(SWSA 6) Trench Water**

P. A. Taylor

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Treatability Study for WAG 6 (SWSA 6) Trench Water

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EXECUTIVE SUMMARY

The Environmental Restoration Program at Oak Ridge National Laboratory (ORNL) is examining methods for remediation and final closure of Waste Area Grouping 6 (WAG 6) under a Resource Conservation and Recovery Act (RCRA) closure plan. WAG 6 consists primarily of Solid Waste Storage Area 6 (SWSA 6), where solid low-level radioactive waste (and some hazardous waste) was buried from 1968 to 1985 in shallow trenches. To support the feasibility study that is being prepared for closure of WAG 6, lab-scale treatability tests were performed on the water from selected trenches in SWSA 6 to determine if the trench water could be treated at the existing wastewater treatment plants at ORNL.

Water from 23 of the 500 trenches in SWSA 6 has been sampled and analyzed to date, and the 4 most highly contaminated trenches identified thus far supplied the water used in the treatability tests. The softening and ion-exchange processes used in the Process Wastewater Treatment Plant (PWTP) reduced the ^{90}Sr concentration, which was the only radionuclide present in the trench water at above the discharge limits, from 260 to 0.2 Bq/L. The air stripping and activated carbon adsorption processes used in the Nonradiological Wastewater Treatment Plant (NRWTP) removed volatile and semivolatile organics (mostly toluene, xylene, and naphthalene), which were the main contaminants in the trench water, to below detection limits. The trench water treated in the lab-scale equipment easily met all discharge limits for the PWTP and the NRWTP.

1. INTRODUCTION

The Environmental Restoration Program at Oak Ridge National Laboratory (ORNL) is examining methods for remediation and final closure of Waste Area Grouping 6 (WAG 6) under a Resource Conservation and Recovery Act (RCRA) closure plan. WAG 6 consists primarily of Solid Waste Storage Area 6 (SWSA 6), where solid low-level radioactive waste (and some hazardous waste) was buried from 1968 to 1985 in about 500 shallow trenches. Various technology demonstrations will be conducted on selected trenches at the site during the next few years as part of the feasibility study required by the RCRA closure plan. Some of these demonstrations, and probably the final remediation, will require that the trenches be dewatered. Treatability tests were performed to determine if the water removed from the trenches could be treated at the existing ORNL wastewater treatment facilities.

The ORNL Process Wastewater Treatment Plant (PWTP) treats water that contains very low concentrations of radionuclides—primarily ^{90}Sr and ^{137}Cs . The flow sheet for the PWTP is shown in Fig. 1. Most of the calcium and magnesium, and about 70% of the ^{90}Sr , is removed by precipitation at a pH of 11.5 in the softener. The clarified water is then treated with a strong-acid cation resin (Dowex HCR-S), which removes the remaining ^{90}Sr . For the normal PWTP flow rate of 450 L/min (120 gal/min), the empty bed contact time for the water with the resin is 6.2 min. If the water needs to be treated to remove ^{137}Cs , then chabazite zeolite columns are used, either in series or parallel with the routine PWTP processes. The discharge requirements for the effluent from the PWTP are listed in DOE Order 5400.5.¹ Derived Concentration Guide (DCG) values, which are the concentrations below which wastewater does not require treatment, are shown in Table 1 for selected radionuclides. The sludge and spent zeolite produced by the PWTP are currently being stored, pending the development of drying/ solidification processes for the wastes and the startup of new disposal facilities.

Table 1. Derived concentration guide values^a
for selected radionuclides
(from DOE Order 5400.5)

Radionuclide	Concentration (Bq/L)
^3H	74,000
^{60}Co	185
^{90}Sr	37
^{137}Cs	111

^aWastewater containing less than the DCG values
does not require treatment.

ORNL DWG 89A-954

Fig. 1. Process wastewater treatment plant (PWTP).

The Nonradiological Wastewater Treatment Plant (NRWTP) is a new facility that started operation in March 1990. The flow sheet for this facility is shown in Fig. 2. Most of the wastewater that enters the plant is routed to the nonmetals tank and is treated for organic removal only. The waste acceptance criteria for the NRWTP specifies that the water entering the plant must contain less than the DCG values for all radionuclides. The wastewater flow rate to the plant has averaged 950 L/min (250 gal/min), with a high range of about 1300 L/min (350 gal/min). The air stripper is filled to a height of 6.4 m (25 ft) with a high efficiency packing (3.5-in. Lanpac, J antec Products, Inc., Agoura Hills, CA). At normal operating conditions, the air stripper has about nine theoretical stages. The carbon columns, which contain about 30,000 kg of activated carbon (Cecarbon GAC-30, Atochem, Inc.), have an empty bed contact time of 50 min at a flow rate of 1300 L/min. The discharge limits for the NRWTP are given in its National Pollutant Discharge Elimination System (NPDES) permit issued by the Tennessee Department of Health and Environment (TDHE). Selected NPDES permit limits are shown in Table 2. The sludge from the NRWTP clarifiers is being stored pending determination of the regulatory status of the waste.

Table 2. Selected NPDES permit limits for NRWTP

Contaminant	Daily maximum (mg/L)
Cadmium	1.20
Chromium	2.77
Copper	3.38
Lead	0.69
Zinc	2.61
Total toxic organics ^a	2.13

^aSee Sect. 4.4.

2. TEST OBJECTIVES

The objective of the treatability tests on the WAG 6 trench water was to demonstrate whether the existing wastewater treatment plants at ORNL can effectively treat the WAG 6 trench water to meet the applicable discharge limits. Since the processes used in the treatment plants (precipitation, ion exchange, air stripping, and carbon adsorption) are well known processes for which removal efficiencies can be estimated, the treatability tests focused on identifying possible interferences that might be caused by other contaminants in the trench water. Contaminants, such as surfactants, can cause foaming in air strippers, and chelating agents can interfere with ion-exchange processes. Because of the difficulty of identifying all of the possible interfering contaminants, treatability tests (rather than analytical analyses) were used to determine if any significant interferences were present in the trench water.

ORNL DWG 89A-955

Fig. 2. Nonradiological wastewater treatment plant (NRWTP).

3. DESCRIPTION OF WORK

This task involved: (1) initial selection of the trenches to be examined, based on previous analytical results; (2) sampling of the selected trenches to obtain current contaminant concentrations; (3) selecting four trenches with the highest levels of contaminants; and (4) conducting lab-scale treatability tests on water from these trenches.

3.1 INITIAL TRENCH SELECTION

Analytical results are available from two previous sampling programs of trench water at WAG 6. The first was conducted in 1986-87, and involved water from eight trenches² (see Appendix A). The second sampling program was conducted in 1989, and involved water from 15 trenches³ (see Appendix B). The 23 trenches that were sampled represent about 5% of the total number of trenches in SWSA 6. These sampling programs showed that volatile organics (mostly aromatics) are the main contaminants in the trench water. Two trenches (T-41 and T-82) contained ⁹⁰Sr above the Department of Energy (DOE) discharge limit. None of the trench samples contained heavy metal concentrations above the discharge limits for the NRWTP. Most of the samples also contained tritium; however, no treatment options are currently available for low concentrations of tritium in wastewater, and the average concentrations are below the DOE discharge limits.¹ Based on the results of these samples, the seven trenches with the highest concentrations of contaminants were selected for further study.

3.2 SAMPLING AND ANALYSIS

Analytical samples were obtained from the seven selected trenches using existing shallow wells on November 10, 1989. The samples were collected using a vacuum pump to pull the trench water up through teflon tubing directly into the sample bottles, as was done for the previous sampling program.³ The samples were analyzed for radionuclides and organics, as described in the Analytical Methods section below. The radionuclide results and selected organic results from these analyses are shown in Table 3, and the full list of organic results is given in Appendix C.

After these samples had been analyzed, water from several trenches around T-13 was sampled by Brian Spalding (Environmental Sciences Division, ORNL) and analyzed for organics in preparation for a remediation test. The water from one of these trenches (T-16) contained high concentrations of volatile organics (69 mg/L toluene, 170 mg/L ethylbenzene, and 77 mg/L xylene). These results were used, along with the results in Table 3, in selecting the trenches for the treatability tests.

Table 3. Results of initial analyses of trench water samples

Contaminant	Contaminant concentrations for trench samples						
	T-13	T-41	T-85	T-105	T-279	T-288	T-318
Radionuclides (Bq/L)							
^{60}Co	1.5	ND ^a	0.5	ND	ND	1.3	ND
^{137}Cs	8.4	0.4	100.	2.5	ND	2.4	5.3
^{90}Sr	0.4	661.	17.	1.6	3.0	0.7	0.7
^3H	9900.	16000.	1100.	2700.	520.	180.	1300.
Organics (mg/L)							
Acetone	0.18	NA ^b	0.3	0.44	0.18	0.22	0.29
Methylene chloride	0.07	-	2.0	0.04	0.04	0.04	0.05
Toluene	6.7	-	76.	1.9	9.3	0.18	7.8
Xylene	26.	-	13.	9.8	2.1	0.42	7.1
Phenol	0.13	-	0.56	0.02	ND	ND	0.03
4-Methylphenol	1.4	-	3.8	0.37	0.06	ND	0.53
2,4-dimethylphenol	0.08	-	0.21	0.02	0.01	ND	0.29
Naphthalene	1.4	-	5.1	0.87	0.49	0.02	0.61

^aND = not detected.^bNA = not analyzed.

3.3 FINAL TRENCH SELECTION

The final selection of the trenches for the treatability tests was made based on the analytical results from the sampling described above. The goal was to select the trenches with the highest concentrations and widest variety of contaminants. The trench with the highest ^{90}Sr concentration (T-41) was selected for the softening and ion-exchange tests. The three trenches with the highest concentrations of organics (T-13, T-16 and T-105) were selected for the air stripping and carbon adsorption tests.

3.4 TREATABILITY TESTS

The treatability tests simulate the processes in the PWTP and NRWTP using full-strength trench water. Any trench water actually treated at the PWTP or NRWTP will be mixed with a large volume of other wastewater. Also, the trench selection procedure was designed to obtain the most contaminated trench water that had been identified to date (based on sampling 5% of the trenches), so the treatability tests represent a severe test of the capabilities of the PWTP and NRWTP to treat the trench water.

4. MATERIALS AND METHODS

4.1 WATER SAMPLES

The water samples for the treatability tests were collected using a vacuum pump to pull the water up through teflon tubing into 4-L amber glass bottles (three bottles per trench). A small sample was collected at the same time using a baler, to determine if any volatile organics were removed by the vacuum pump. Analytical samples were poured from the main sample bottles and from the baler sample within an hour. The bottles for the analytical samples were 40-mL glass vials with teflon lined septums for volatiles, 1-L glass bottles with teflon lined lids for semivolatiles and radionuclides, and 40-mL polyethylene bottles for dissolved metals. The samples for the treatability tests were stored at room temperature until they were used (maximum of 24-h storage time). Trenches T-13 and T-41 were sampled on February 21, 1990, and trenches T-16 and T-105 were sampled on April 30, 1990.

4.2 TEST EQUIPMENT

The water softening test was performed in batch mode in a 2-L glass beaker. Whatman #41 paper was used to filter the decant water. A small ion-exchange column (1.6 cm ID by 20 cm high) filled to a height of 6.5 cm with 13 mL of HCR-S resin was used to model the ion-exchange columns at the PWTP. A column (9.5 cm ID by 60 cm high) filled to a height of 19 cm with 1.3 L of chabazite zeolite (TSM-300) was used to model the zeolite columns at the PWTP.

Because of the large number of theoretical stages in the NRWTP air stripper (about nine for aromatics), it is not practical to construct a laboratory unit to directly simulate this equipment. A small air stripper (8 cm ID by 60 cm high) filled to a height of 35 cm with ceramic saddles (0.6 cm) was constructed. A distributor screen and a packing support were fabricated from stainless steel screen.

Correlations for calculating the height of a theoretical stage are not well established for laboratory-size packings. Sherwood and Hollaway⁵ developed correlations for various packings that depend on the liquid density, viscosity, diffusivity and loading rate, and two constants that depend on the size and shape of the packing. Packing constants were available for 1.3-, 2.5- and 5-cm ceramic saddles, but not for the 0.6-cm size used in the laboratory air stripper. For the larger packings, the height of a theoretical stage varied between 46 and 52 cm for the liquid loading used in the treatability tests, so assuming that the 0.6-cm packing would have a similar performance to the larger sizes, the laboratory unit should have about 3/4 of a theoretical stage ($35/46 \approx 3/4$).

The number of theoretical stages for the lab-scale air stripper was also determined experimentally by using pure water saturated with xylene to measure xylene removal, which was compared with that predicted for one theoretical stage. The air stripper reduced the xylene concentration from 40 to 12 mg/L in one pass. Simulation of the air stripper using the rigorous multistage separation model (RADFRC) in ASPEN (JSD Simulation Service Co., Denver CO) predicts that one theoretical stage would reduce the xylene concentration from 40 to 3 mg/L at the conditions used in the test. Thus, the experimental test also shows that the air stripper has about 3/4 of a theoretical stage $[(40 - 12)/(40 - 3) \approx 3/4]$.

A column (9.5 cm ID by 60 cm high) filled to a height of 28 cm with 2 L of granular activated carbon (Cecarbon GAC-30, Atochem, Inc.) was used to model the carbon columns in the NRWTP. All of the columns used in the treatability tests have the same aspect ratio (height to diameter ratio) as the corresponding columns in the full-scale treatment plants, and the flow rates for the laboratory units were chosen so that the contact time between the water and the treatment media (ion-exchange resin or activated carbon) was the same as for the full-scale units.

4.3 TEST PROCEDURES

A sample of the T-41 trench water was softened at a pH of 11.5 (using NaOH) with 2.5 mg/L iron (Ferrifloc) and 0.3 mg/L Betz 1100 polymer added, as is used at the PWTP. The water was stirred gently for 1 h, and then the floc was allowed to settle, and the water was decanted and filtered. The filtered water was processed through the small ion-exchange column at a rate of 2 mL/min. An unsoftened sample of T-41 trench water was processed through the zeolite column at a rate of 65 mL/min. Samples of the untreated, softened, ion-exchange treated and zeolite treated water were collected for analysis of radionuclides and dissolved metals.

Samples of water from trenches T-13, T-16, and T-105 were treated by air stripping and activated carbon adsorption. The bottles of water from each trench were composited into a large glass carboy, leaving the settled solids in the bottom of the bottles. (Note: At the NRWTP, any suspended solids in the wastewater entering the plant are removed in the clarifier and/or the filters.) The water was pumped from the carboy into the top of the air

stripper at a rate of 400 mL/min. The air flow rate up through the stripper was 20 L/min. The temperatures of the air and water entering and leaving the stripper were measured periodically, as was the pressure drop across the column. Samples of the treated and untreated water were collected for volatile and semivolatile analysis. The treated water from the air stripper was then processed through the activated carbon column at a rate of 57 mL/min. Samples of the activated carbon treated water were collected for analysis of volatiles, semivolatiles, dissolved metals, and radionuclides.

The air stripper and activated carbon column were rinsed with deionized water for at least 5 min following each test so that there would not be any cross contamination between the different trench-water samples during the tests.

4.4 ANALYTICAL METHODS

All samples were analyzed at the ORNL Analytical Laboratory, which is qualified under the Environmental Protection Agency (EPA) Contract Laboratory Program. Organics were analyzed with a gas chromatograph-mass spectrometer (GC-MS), using EPA Methods 8240 for volatiles and 8270 for semivolatiles. The concentration of total toxic organics (TTO) is determined by summing all quantifiable values >0.01 mg/L measured in the volatiles and semivolatiles analysis. Samples were analyzed for ^{90}Sr using EPA Method 905.0, tritium was measured by EPA Method 906.0, and a gamma scan (EPA Method 901.1) was used to identify other radionuclides. Dissolved metals were measured using an inductively coupled plasma spectrophotometer (ICP), as prescribed in EPA Method 200.7.

5. RESULTS

5.1 SAMPLE METHOD

The concentration of volatile organics in the samples taken with a baler are compared to that of the samples taken with a vacuum pump in Table 4. The results show that the vacuum pump did not remove any volatile organics from the samples that were used in the treatability tests.

5.2 TRENCH T-41

The radionuclide concentrations of the treated and untreated trench water are shown in Table 5. The untreated water was an opaque brownish-green color with a high concentration of suspended solids. The softening process removed all of the solids, producing clear water for the ion-exchange test. The softening process also removed almost 99% of the ^{90}Sr in the water, which is better than is typically seen in the PWTP. The ion-exchange resin removed essentially all of the remaining ^{90}Sr . The zeolite was also very effective at removing ^{90}Sr , and unexpectedly removed 82% of the tritiated water from the unsoftened trench water. A literature search revealed one other example of concentrating tritiated water with zeolites.⁶ Further tests will be performed on this phenomenon.

Table 4. Effect of sampling method on volatile organics

Sample description	Volatile organic concentration (mg/L)		
	Acetone	Toluene	Xylene
Trench T-13			
Vacuum pump	5.3	5.6	20
Baler	3.4	3.3	21
Trench T-16			
Vacuum pump	ND ^a	47	69
Baler	ND	59	70
Trench T-105			
Vacuum pump	ND	40	17
Baler	ND	36	16

^aND = not detected.**Table 5. Treatment results for T-41 trench water**

Treatment	Contaminant concentration (Bq/L)		
	³ H	⁹⁰ Sr	¹³⁷ Cs
Untreated	8,400	260	0.5
Softened	8,000	3.6	0.3
Ion exchange	7,900	0.2	<0.1
Zeolite	1,500	<0.1	<0.2
DCG ^a value	74,000	37	111

^aDCG = derived concentration guide (see Sect. 1).

5.3 TRENCH T-13

The concentration of volatile organics in the water entering the air stripper was much lower than that measured at the time the samples were collected (compare Tables 4 and 6). Apparently, storing the trench water for about 20 h and/or transferring it into the open carboy was sufficient to strip most of the volatile organics from the water, although this did not happen with the water from the other trenches. The water entering the air stripper was still an opaque brownish-green color, even though the heavier solids had been left in the original sample bottles. After air stripping, the water was a brownish-orange color, from the oxidation of ferrous ions into ferric hydroxide. The water temperature entering and exiting the air stripper was 19°C, and the air temperature decreased from 23 to 22°C through the stripper. The pressure drop across the column varied from 15 to 17 Pa (0.6 to 0.7 in. H₂O). There was not any visible foaming in the air stripper. Two samples of treated and untreated water were collected for volatiles analysis, and one sample of each for semivolatiles. The effluent from the activated carbon column, which was crystal clear, was sampled twice for volatiles and once for semivolatiles, dissolved metals, and radionuclides. All of the organic results are shown in Table 6, and the results for the other analyses are shown in Table 9.

Table 6. Treatment results for T-13 trench water

Contaminant	Contaminant concentration (mg/L)		
	Not treated	Air stripper	Activated carbon
Volatiles (two samples each)			
Acetone	<0.010	<0.010	<0.010
Toluene	0.011	0.006	<0.005
Xylene	0.034	0.020	<0.005
Semivolatiles (one sample each)			
Naphthalene	1.4	1.1	<0.01
4-Methylphenol	0.42	0.43	<0.01
2,4-Dimethylphenol	0.06	0.06	<0.01

5.4 TRENCH T-16

The water from trench T-16 lost only a small amount of volatile organics during handling prior to pumping the water into the air stripper (compare Tables 4 and 7). As with T-13 trench water, the T-16 trench water changed from brownish-green to brownish-orange after air stripping and was crystal clear after carbon adsorption. The water temperature decreased from 22 to 21°C in the air stripper, and the air temperature held at 23°C. The pressure drop across the air stripper was 12 Pa (0.05 in. H₂O), and there was not any visible foaming. The concentration of organics for the treated and untreated water is shown in Table 7, and additional results for the activated carbon treated water is shown in Table 9.

Table 7. Treatment results for T-16 trench water

Contaminant	Contaminant concentration (mg/L)		
	Not treated	Air stripper	Activated carbon
Volatiles (two samples each)			
Toluene	41	17	<0.005
Xylene	52	28	<0.005
Semivolatiles (one sample each)			
Naphthalene	13	6.1	<0.01
4-Methylphenol	1.5	1.3	<0.01
Phenol	0.59	0.51	<0.01
2,4-Dimethylphenol	0.31	0.14	<0.01

5.5 TRENCH T-105

The water from trench T-105 lost only a small amount of volatile organics during handling prior to pumping the water into the air stripper (compare Tables 4 and 8). The water changed from brownish-green to brownish-orange to clear during treatment, as did the water from the other trenches. The water temperature decreased from 20 to 19°C in the air stripper, and the air temperature increased from 19 to 20°C. The pressure drop across the air stripper was 12 Pa (0.05 in. H₂O), and there was not any visible foaming. The concentration of organics for the treated and untreated water is shown in Table 8, and additional results for the activated carbon treated water is shown in Table 9.

Table 8. Treatment results for T-105 trench water

Contaminant	Contaminant concentration (mg/L)		
	Not treated	Air stripper	Activated carbon
Volatiles (two samples each)			
Toluene	34	13	<0.005
Xylene	12	5.0	<0.005
Semivolatiles (one sample each)			
Naphthalene	3.1	2.0	<0.01
4-Methylphenol	4.1	4.0	<0.01
2,4-Dimethylphenol	0.45	0.40	<0.01
Phenol	0.30	0.18	<0.01

Table 9 shows the concentrations of selected contaminants in the trench water samples that were fully treated (i.e., softened and ion exchange treated for T-41, and air stripper and activated carbon treated for T-13, T-16 and T-105). All of the contaminants shown have established effluent discharge limits set for either the PWTP or the NRWTP, and the treated trench water is substantially below these limits. Complete analytical results for metals and organics in the treated trench water samples are given in Appendix D.

Table 9. Contaminant concentrations in treated trench water

Contaminant	Trench water sample location				Discharge limit
	T-13	T-41	T-16	T-105	
Radionuclides (Bq/L)					
³ H	1900	180	180	1300	74,000
⁶⁰ Co	<0.1	0.3	0.3	0.6	185
⁹⁰ Sr	<0.1	0.5	0.5	0.6	37
¹³⁷ Cs	<0.1	0.1	<0.1	0.5	111
Metals (mg/L)					
Cd	<0.007	<0.005	<0.005	<0.005	1.20
Cr	<0.004	0.006	0.006	0.009	2.77
Cu	0.28	<0.005	<0.005	<0.005	3.38
Pb	<0.03	<0.05	<0.05	<0.05	0.69
Zn	0.11	<0.005	<0.005	<0.005	2.61
Total toxic organics (mg/L)	<0.01	<0.01	<0.01	<0.01	2.13

6. DISCUSSION

The high removal efficiency of the softening and ion-exchange treatment for ⁹⁰Sr in T-41 trench water shows that there were not any complexing agents or other interferences in the water. The sampling that has been done to date at SWSA 6 indicates that water from very few of the trenches will need to be treated for radionuclides.

Using deionized water spiked with 40 mg/L xylene, the lab-scale air stripper removed 68% of the xylene in one pass. The removal efficiency for toluene and xylene in the trench water samples varied from 41 to 62%, with an average of 52%. The reduction in organic removal efficiency for the trench water compared to deionized water indicates that the trench

water contains something that interferes slightly with air stripping, probably the suspended solids, (60 to 91% reduction in stripping efficiency compared to pure water).

To date, the concentration of volatile organics entering the air stripper at the NRWTP has been too low to allow experimental determination of the air stripper performance. The rigorous multistage separation model (RADFRC) in ASPEN (JSD Simulation Service Company, Denver, Colorado) was used to simulate the air stripper. At the maximum water flow rate for the NRWTP of 1300 L/min, and at water and air temperatures of 21°C, ASPEN predicts that the NRWTP air stripper would remove 90% of the xylene or toluene present in the water at each theoretical stage. Since the NRWTP air stripper has nine theoretical stages at these conditions, a feed stream containing 100 mg/L xylene would contain 10^{-7} mg/L at the exit of the air stripper. At wintertime conditions of 10°C water temperature and -7°C air temperature, ASPEN predicts that each stage would remove 80%, so the same feed stream would contain 10^{-4} mg/L xylene after air stripping during cold weather.

If the removal efficiency of each theoretical stage is reduced by 60% because of interfering contaminants in the trench water (the worst case seen in the treatability tests) the effluent from the NRWTP air stripper would contain 0.3 mg/L xylene for an inlet stream of 100 mg/L at winter conditions. This effluent would be below the NPDES limit of 2.13 mg/L for total toxic organics at the NRWTP, even before the activated carbon treatment, which would further reduce the organic concentration. The above calculations show that the NRWTP air stripper is easily able to treat the trench water from WAG 6, even at extreme conditions.

The lab-scale activated carbon column was able to produce water containing undetectable concentrations of organics even though the feed to this column contained much higher concentrations of organics than the feed to the NRWTP carbon columns. The NRWTP columns would be expected to produce lower concentrations for the same wastewater, because of the higher number of stages in its air stripper.

The results of the treatability tests demonstrate that the trench water from WAG 6 can be treated at the PWTP for ^{90}Sr , and at the NRWTP for organics.

7. CONCLUSIONS

Lab-scale treatability tests on trench water from SWSA 6 have shown that the water can be successfully treated by existing wastewater treatment plants at ORNL. Water from the four most highly contaminated trenches identified to date was used in the treatability tests. The softening and ion-exchange processes used in the Process Wastewater Treatment Plant reduced the ^{90}Sr concentration, which was the only radionuclide present in the trench water at above the discharge limits, from 260 to 0.2 Bq/L. The air stripping and activated carbon adsorption processes used in the NRWTP removed volatile and semivolatile organics, which were the main contaminants in the trench water, to below detection limits. The trench water treated in the lab-scale equipment easily met all discharge requirements for effluent from the PWTP and the NRWTP.

REFERENCES

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3. B. P. Spalding, Environmental Sciences Division, ORNL, unpublished data, 1989.
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Appendix A

RESULTS OF ANALYSES OF TRENCH WATER SAMPLES FROM SWSA 6, 1986-87*

*D. K. Solomon et al., *Sampling and Analysis of SWSA 6 Trench Leachates and Groundwaters*, ORNL/TM-10813, Martin Marietta Energy Systems, Inc., Oak Ridge National Lab., December 1988.

Table A1. Inductively-coupled plasma spectrometric analyses of trench water (in mg/l)

Element	Well ID/sampling date							
	T41 3/11/86	T41 12/4/86	T41 3/10/87	T92 4/22/86	T92 12/4/86	T92 3/10/87	T135 4/13/87	T163 4/21/87
Ag	<0.050	<0.050	<0.005	<0.050	<0.050	<0.005	<0.005	<0.005
Al	<0.200	<0.200	<0.020	<0.200	<0.200	<0.020	0.02	0.035
As	<0.330	<0.10	<0.010	<0.005	<0.10	<0.010	<0.010	<0.010
B	0.35	0.48	0.17	0.08	<0.08	0.084	0.25	0.094
Ba	0.18	0.14	0.2	0.14	0.21	0.089	0.16	0.061
Be	<0.002	<0.002	<0.0002	<0.002	<0.002	<0.0002	<0.0002	<0.0002
Ca	140	120	110	37	48	34	89	31
Cd	0.005	<0.005	0.0019	<0.005	<0.005	<0.0005	0.004	0.0016
Co	0.01	0.015	0.0068	<0.022	<0.010	0.013	0.008	0.0068
Cr	<0.040	<0.040	<0.0053	<0.040	<0.040	<0.0040	<0.0040	<0.0040
Cu	<0.020	<0.020	<0.002	<0.020	<0.020	<0.002	0.002	0.0025
Fe	23	37	34	7.1	23	6.2	50	<1.000
Ga	<0.300	<0.300	<0.030	<0.300	<0.300	<0.030	<0.030	<0.030
Li	<0.200	<0.200	<0.020	<0.200	<0.200	<0.020	<0.1900	<0.020
Mg	25	26	24	9.1	9.6	6.8	17	8.1
Mn	5	5.2	4.5	9.4	8	6.6	3.5	1.5
Mo	<0.040	<0.040	0.028	<0.040	<0.040	<0.004	<0.0040	<0.004
Na	42	28	27	7.1	23	9.8	7.1	1.8
Ni	0.08	0.27	0.034	0.06	<0.06	<0.006	<0.0120	<0.006
P	0.41	0.54	0.46	<0.300	2	0.2	1.8	0.79
Pb	<0.200	<0.200	<0.020	<0.010	<0.20	<0.020	<0.020	<0.020
Sb	<0.020	<0.20	<0.020	<0.200	<0.200	<0.020	<0.020	<0.020
Se	<0.020	<0.20	<0.020	<0.010	<0.20	<0.020	<0.020	<0.020
Si	3.9	3.6	3.3	4.7	6.2	3.8	1.9	1.1
Sn	<0.050	<0.050	<0.005	<0.050	<0.050	<0.005	<0.0050	<0.0050
Sr	0.14	0.23	0.2	0.11	0.13	0.074	0.15	0.042
Ti	<0.020	<0.020	<0.002	<0.020	<0.020	<0.002	0.002	0.0057
V	<0.010	<0.0010	0.001	<0.010	<0.0010	<0.001	0.001	0.001
Zn	0.041	0.083	0.0073	<0.020	<0.020	0.023	<0.0560	<0.0330
Zr	<0.020	<0.020	<0.002	<0.020	<0.020	<0.002	<0.0020	<0.002

Table A1 (continued)

Element	Well ID/sampling date							
	T219 1/21/87	T257 12/5/86	T257 1/21/87	T257 3/10/87	T260-2 4/13/87	T288 3/21/86	T288 12/5/86	T288 3/10/87
Ag	<0.03	<0.050	<0.005	<0.005	<0.005	<0.050	<0.050	<0.005
Al	<0.120	<0.200	0.03	<0.020	0.02	<0.200	<0.200	<0.020
As	<0.060	<0.10	<0.010	<0.010	<0.010	<0.005	<0.10	<0.010
B	<0.048	<0.08	0.022	<0.008	0.008	0.08	<0.08	<0.008
Ba	0.1	<0.099	0.12	0.068	0.13	0.2	0.28	0.18
Be	<0.0012	<0.002	<0.0002	<0.0002	<0.0002	<0.002	<0.002	<0.0002
Ca	150	31	36	32	38	47	72	52
Cd	<0.00	<0.005	0.0012	<0.0005	0.0033	<0.005	<0.005	0.0021
Co	0.014	<0.010	0.047	<0.001	0.019	<0.010	<0.016	0.0099
Cr	<0.024	<0.040	0.0049	<0.004	<0.0040	<0.040	<0.040	<0.004
Cu	<0.012	<0.020	<0.002	<0.002	0.002	<0.020	<0.020	<0.002
Fe	24	0.33	17	0.0087	40	50	69	45
Ga	<0.180	<0.300	<0.030	<0.030	<0.030	<0.300	<0.300	<0.030
Li	<0.120	<0.200	<0.020	<0.020	<0.0200	<0.200	<0.200	<0.020
Mg	22	4.6	11	3.7	13	13	18	12
Mn	5.7	0.35	7	0.00081	4.3	5.8	8.5	5.4
Mo	<0.024	<0.040	0.011	<0.004	<0.0040	<0.040	<0.040	0.014
Na	2.9	13	18	8.5	130	2.6	3.7	1.4
Ni	<0.036	<0.06	0.014	<0.006	<0.0060	0.06	<0.06	0.006
P	<0.180	0.62	0.12	0.13	0.1	0.63	0.84	0.64
Pb	<0.120	<0.20	<0.020	<0.020	<0.020	<0.010	<0.20	<0.020
Sb	<0.120	<0.20	<0.020	<0.020	<0.020	<0.020	<0.20	<0.020
Se	<0.120	<0.20	<0.020	<0.020	<0.020	<0.010	<0.20	<0.020
Si	0.53	2	0.14	2.1	1.3	4.3	5.4	3.3
Sn	<0.030	<0.050	<0.005	<0.005	<0.0050	<0.050	<0.050	<0.005
Sr	0.17	0.061	0.072	0.05	0.075	0.092	0.13	0.078
Ti	<0.012	<0.020	0.0048	<0.002	0.0038	<0.020	<0.020	<0.002
V	0.0097	<0.001	<0.0010	0.0018	0.001	<0.010	<0.001	<0.001
Zn	<0.012	<0.020	0.44	0.006	<0.0190	<0.020	<0.020	0.0069
Zr	<0.012	<0.020	<0.002	<0.002	<0.0020	<0.020	<0.020	<0.002

Table A2. Chemical, ion chromatographic, and atomic adsorption analyses of trench water (in mg/L)

Analysis	Well ID/sampling date						
	T41 3/11/86	T41 12/4/86	T41 3/10/87	T92 4/22/86	T92 12/4/86	T92 3/10/87	T288 3/10/87
Chemical							
MH ₃	5.31	NA ^a	NA	2.2	NA	NA	NA
Cyanide	NA	NA	<0.002	NA	NA	<0.002	<0.002
Total C	189	NA	NA	88	NA	NA	NA
IOC	141	NA	NA	60	NA	NA	NA
TOC	NA	NA	NA	NA	NA	NA	NA
Ion chromatographic							
NO ₃ ⁻	<5	1.0	3	<5.0	<1	<1.0	<1.0
F ⁻	<10.0	1	<1.0	<1.0	4		<1.0
SO ₄ ²⁺	132	150	9	6	6	<5.0	<1.0
Cl ⁻	27	500	20	17	80	14	6
Br ⁻	<5.0	<5.0	<1.0	<5.0	<5.0	<1.0	<1.0
PO ₄ ³⁻	<5.0	<1.0	<1.0	<5.0	<1	<1.0	<1.0
Atomic absorption							
Hg	<0.0001	NA	NA	<0.0002	NA	NA	NA

Analysis	Well ID/sampling date						
	T219 1/21/87	T257 12/5/86	T257 1/21/87	T257 3/10/87	T260-2 4/13/87	T288 3/21/86	T288 12/5/86
Chemical							
MH ₃	7.2	NA	0.64	NA	1.64	21.8	NA
Cyanide	<0.002	NA	<0.002	<0.002	<0.002	NA	NA
Total C	NA	NA	NA	NA	NA	148	NA
IOC	NA	NA	NA	NA	NA	129	NA
TOC	11	NA	4.4	NA	2.5	NA	NA
Ion chromatographic							
NO ₃ ⁻	<1.0	<1.0	<1.0	4	<5.0	<5.0	<1
F ⁻	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	4
SO ₄ ²⁺	8	5	29	5	<5.0	<5.0	<1
Cl ⁻	7	5	15	4	300	9.6	48
Br ⁻	<5.0	<5.0	<5.0	<1.0	<5.0	<5.0	<5.0
PO ₄ ³⁻	<1.0	1	<1.0	1.5	<5.0	<5.0	1.0
Atomic absorption							
Hg	<0.0002	NA	<0.0002	NA	<0.0001	<0.0001	NA

^a NA = Not analyzed.

Table A3. Radiochemical analyses of trench water (in Bq/L)

Analysis	Well ID/sampling date					
	T41 3/11/86	T41 12/4/86	T41 3/10/87	T92 4/22/86	T92 12/4/86	T92 3/10/87
Gross alpha	8.6 $\pm$ 5.3	110 $\pm$ 45	1.1 $\pm$ 1.8	1.5 $\pm$ 1.7	0.7 $\pm$ 1.4	1 $\pm$ 1
Gross beta	5400 $\pm$ 100	18,000 $\pm$ 1000	16,000 $\pm$ 1000	150 $\pm$ 10	16 $\pm$ 4	9.4 $\pm$ 3.4
³ H	2000 $\pm$ 100	340,000 $\pm$ 10,000	180,000 $\pm$ 10,000	2200 $\pm$ 100	2600 $\pm$ 100	1500 $\pm$ 100
¹⁴ C	1.9	NA ^a	2900 $\pm$ 100	42 $\pm$ 18	NA	<21
⁶⁰ Co	NA	<0.6	<0.6	0.22 $\pm$ 0.08	<0.3	<0.1
⁹⁰ Sr	3600 $\pm$ 100	3100 $\pm$ 100	NA	86 $\pm$ 12	0.84 $\pm$ 0.20	NAL
⁹⁹ Tc	<100	<100	<100	<100	<100	<100
¹³⁷ Cs	88 $\pm$ 6	130 $\pm$ 10	140 $\pm$ 10	2.6 $\pm$ 0.2	0.33 $\pm$ 0.28	0.59 $\pm$ 0.13
²²⁸ Th	0.17 $\pm$ 0.2	NAL ^b	NAL	NAL	NAL	NAL
²³⁰ Th	0.03 $\pm$ 0.01	NAL	NAL	NAL	NAL	NAL
²³⁴ U	0.63 $\pm$ 0.07	NAL	NAL	NAL	NAL	NAL
²³⁵ U	0.11 $\pm$ 0.03	NAL	NAL	NAL	NAL	NAL
²³⁸ U	0.36 $\pm$ 0.05	NAL	NAL	NAL	NAL	NAL
Total Ra	0.47 $\pm$ 0.18	NAL	NAL	<0.02	NAL	NAL

^a NA = Not analyzed.

^b NAL = Not analyzed.

Table A3 (continued)

Analysis	Well ID/sampling date					
	T135 4/13/87	T163 4/21/87	T219 1/21/87	T257 12/5/86	T257 1/21/87	T257 3/10/87
Gross alpha	0.6 $\pm$ 1	1 $\pm$ 1.7	<2.0	2.9 $\pm$ 2.4	4.2 $\pm$ 3	2 $\pm$ 2.1
Gross beta	5400 $\pm$ 100	26. $\pm$ 5	20 $\pm$ 5	9.4 $\pm$ 3.7	1100 $\pm$ 100	1 $\pm$ 2.4
³ H	33,000 $\pm$ 1000	620 $\pm$ 50	380 $\pm$ 40	23,000 $\pm$ 1000	3900 $\pm$ 100	12,000 $\pm$ 1000
¹⁴ C	2600 $\pm$ 100	32 $\pm$ 21	30 $\pm$ 20	NA	410 $\pm$ 30	1 $\pm$ 20
⁶⁰ Co	0.7 $\pm$ 0.22	0.33 $\pm$ 0.18	<2	<0.3	1.4 $\pm$ 0.4	<0.2
⁹⁰ Sr	NA	NAL	NAL	0.26 $\pm$ 0.13	NA	NAL
⁹⁹ Tc	<100	<100	<100	<100	<100	<100
¹³⁷ Cs	40 $\pm$ 1	2.4 $\pm$ 0.2	3 $\pm$ 0.4	<0.3	2.1 $\pm$ 0.4	<0.2
²²⁸ Th	NAL	NAL	NAL	NAL	NAL	NAL
²³⁰ Th	NAL	NAL	NAL	NAL	NAL	NAL
²³⁴ U	NAL	NAL	NAL	NAL	NAL	NAL
²³⁵ U	NAL	NAL	NAL	NAL	NAL	NAL
²³⁸ U	NAL	NAL	NAL	NAL	NAL	NAL
Total Ra	NAL	NAL	0.11 $\pm$ 0.05	NAL	<0.1	NAL

Table A3 (continued)

Analysis	Well ID/sampling date			
	1260-2 4/13/87	1288 3/21/86	1288 12/5/86	1288 3/10/87
Gross alpha	0.4 $\pm$ 1	1.9 $\pm$ 2	2.5 $\pm$ 2.3	1 $\pm$ 2
Gross beta	3.9 $\pm$ 3	4.9 $\pm$ 2.9	52 $\pm$ 7	9.1 $\pm$ 3.4
³ H	310 $\pm$ 40	480 $\pm$ 90	1200 $\pm$ 100	570 $\pm$ 50
¹⁴ C	19 $\pm$ 20	10 $\pm$ 35	NAL	10 $\pm$ 20
⁶⁰ Co	<0.2	0.88 $\pm$ 0.26	0.43 $\pm$ 0.29	<0.2
⁹⁰ Sr	NAL	NAL	12 $\pm$ 1	NAL
⁹⁹ Tc	<100	<100	<100	<100
¹³⁷ Cs	<0.3	<0.1	1.2 $\pm$ 0.3	0.29 $\pm$ 0.11
²²⁸ Th	NAL	NAL	NAL	NAL
²³⁰ Th	NAL	NAL	NAL	NAL
²³⁴ U	NAL	NAL	NAL	NAL
²³⁵ U	NAL	NAL	NAL	NAL
²³⁸ U	NAL	NAL	NAL	NAL
Total Ra	NAL	<0.02	NAL	NAL

Table A4. Gas chromatographic-mass spectrographic analyses of trench water
(in $\mu\text{g/L}$)

[illegible]

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Appendix B

**RESULTS OF ANALYSES OF TRENCH WATER
SAMPLES FROM SWSA 6, 1989***

*B. P. Spalding, Environmental Sciences Division, Oak Ridge National Lab., unpublished data, 1989.

[illegible]

Table B1 (continued)

[illegible]

Table B2. Radionuclide analyses of trench water samples

Trench	Radionuclide concentration (Bq/L)			
	⁶⁰ Co	¹³⁷ Cs	⁹⁰ Sr	Tritium
T-13	<2.0	2.7	5.5	11,000
T-44	<2.0	4.4	1.0	970
T-63	<2.0	6.3	2.0	150
T-82	<2.0	12.	660.	32
T-85	<2.0	7.7	3.3	860
T-92	<2.0	2.6	0.9	880
T-101	<2.0	<2.0	0.4	1,200
T-105	<2.0	4.7	0.8	1,800
T-112	<2.0	27.	0.8	2,700
T-180	<2.0	3.5	1.5	470
T-237	<2.0	2.4	0.1	2,700
T-279	<2.0	36.	35.	950
T-288	<2.0	1.5	14.	250
T-318	<2.0	<2.0	0.04	1,500
T-329	<2.0	<2.0	0.8	99

Table B3. Results of volatile analyses of trench water samples

Compound	Concentration ($\mu\text{g/L}$)				
	T-44	T-63	T-82	T-85	
chloromethane	50.00	10.00	10.00	50.00	U
bromomethane	50.00	10.00	10.00	50.00	U
vinyl chloride	50.00	10.00	10.00	50.00	U
chloroethane	50.00	10.00	10.00	50.00	U
methylene chloride	12.00	4.00	19.00	12.00	JB
acetone	100.00	16.00	6600.00	8300.00	BE
carbon disulfide	25.00	5.00	5.00	25.00	U
1,1-dichloroethane	25.00	5.00	5.00	25.00	U
1,1-dichloroethane	25.00	5.00	5.00	25.00	U
1,2-dichloroethane (total)	25.00	5.00	5.00	25.00	U
chloroform	4.00	0.60	8.00	16.00	J
1,2-dichloroethane	25.00	5.00	5.00	25.00	U
2-butanone	50.00	10.00	10.00	50.00	U
1,1,1-trichloroethane	25.00	5.00	5.00	25.00	U
carbon tetrachloride	25.00	5.00	5.00	25.00	U
vinyl acetate	50.00	10.00	10.00	50.00	U
bromodichloromethane	25.00	5.00	5.00	25.00	U
1,2-dichloropropane	25.00	5.00	5.00	25.00	U
cis-1,3-dichloropropene	25.00	5.00	5.00	25.00	U
trichloroethane	16.00	4.00	5.00	36.00	B
dibromochloromethane	25.00	5.00	5.00	25.00	U
1,1,2-trichloroethane	25.00	5.00	5.00	25.00	U
benzene	25.00	5.00	5.00	25.00	U
trans-1,3-dichloropropane	25.00	5.00	5.00	25.00	U
bromoform	25.00	5.00	5.00	25.00	U
4-methyl-2-pentanone	50.00	5.00	5.00	25.00	U
2-hexanone	50.00	10.00	10.00	50.00	U
tetrachloroethane	25.00	5.00	5.00	25.00	U
1,1,2,2-tetrachloroethane	25.00	5.00	5.00	25.00	U
toluene	220.00	75.00	18.00	3200.00	BE
chlorobenzene	25.00	5.00	5.00	25.00	U
ethylbenzene	25.00	5.00	5.00	80.00	U
styrene	25.00	5.00	5.00	25.00	U
xylene (total)	25.00	5.00	5.00	1900.00	E

Qualifiers: B = Detected in blank.

E = Exceeds calibration range.

J = Below quantification limit, value estimated.

U = Below detection limit.

Table B3. (continued)

Compound	Concentration ($\mu\text{g/L}$)			
	T-13	T-279	T-288	
chloromethane	10.00	10.00	10.00	U
bromomethane	10.00	10.00	10.00	U
vinyl chloride	10.00	10.00	10.00	U
chloroethane	10.00	10.00	10.00	U
methylene chloride	50.00	7.00	3.00	JB
acetone	140.00	10.00	4.00	JB
carbon disulfide	5.00	5.00	5.00	U
1,1-dichloroethene	5.00	5.00	5.00	U
1,1-dichloroethane	5.00	5.00	5.00	U
1,2-dichloroethene (total)	5.00	5.00	5.00	U
chloroform	35.00	5.00	5.00	U
1,2-dichloroethane	5.00	3.00	5.00	U
2-butanone	10.00	10.00	10.00	U
1,1,1-trichloroethane	5.00	5.00	5.00	U
carbon tetrachloride	5.00	5.00	5.00	U
vinyl acetate	10.00	10.00	10.00	U
bromodichloromethane	5.00	5.00	5.00	U
1,2-dichloropropane	5.00	5.00	5.00	U
cis-1,3-dichloropropene	5.00	5.00	5.00	U
trichloroethene	5.00	5.00	5.00	U
dibromochloromethane	5.00	5.00	5.00	U
1,1,2-trichloroethane	5.00	5.00	5.00	U
benzene	240.00	140.00	2.00	J
trans-1,3-dichloropropene	5.00	5.00	5.00	U
bromoform	5.00	5.00	5.00	U
4-methyl-2-pentanone	10.00	10.00	10.00	U
2-hexanone	10.00	10.00	10.00	U
tetrachloroethene	5.00	5.00	5.00	U
1,1,2,2-tetrachloroethane	5.00	5.00	5.00	U
toluene	4300.00	3400.00	180.00	U
chlorobenzene	5.00	5.00	5.00	U
ethylbenzene	7800.00	280.00	5.00	U
styrene	5.00	5.00	5.00	U
xylene (total)	51000.00	1800.00	480.00	E

Table B3. (continued)

Compound	Concentration (µg/L)				
	T-180	T-237	T-318	T-329	
chloromethane	10.00	10.00	10.00	10.00	U
bromomethane	10.00	10.00	10.00	10.00	U
vinyl chloride	10.00	10.00	10.00	10.00	U
chloroethane	10.00	10.00	10.00	10.00	U
methylene chloride	5.00	7.00	19.00	4.00	JB
acetone	20.00	51.00	130.00	64.00	B
carbon disulfide	5.00	0.70	5.00	5.00	U
1,1-dichloroethane	5.00	5.00	5.00	5.00	U
1,1-dichloroethane	5.00	5.00	5.00	5.00	U
1,2-dichloroethane (total)	5.00	5.00	5.00	5.00	U
chloroform	14.00	5.00	1.00	5.00	U
1,2-dichloroethane	5.00	5.00	5.00	5.00	U
2-butanone	10.00	19.00	10.00	20.00	U
1,1,1-trichloroethane	5.00	5.00	5.00	5.00	B
carbon tetrachloride	5.00	5.00	5.00	5.00	U
vinyl acetate	10.00	10.00	10.00	10.00	U
bromodichloromethane	5.00	5.00	5.00	5.00	U
1,2-dichloropropane	5.00	5.00	5.00	5.00	U
cis-1,3-dichloropropene	5.00	5.00	5.00	5.00	U
trichloroethane	5.00	5.00	5.00	5.00	U
1,1,2-trichloroethane	5.00	5.00	5.00	5.00	U
benzene	11.00	28.00	2.00	0.80	U
trans-1,3-dichloropropene	5.00	5.00	5.00	5.00	J
bromoform	5.00	5.00	5.00	5.00	U
4-methyl-2-pentanone	10.00	2.00	5.00	5.00	U
2-hexanone	10.00	10.00	10.00	10.00	U
tetrachloroethane	5.00	5.00	5.00	5.00	U
1,1,2,2-tetrachloroethane	5.00	5.00	5.00	5.00	U
toluene	5000.00	2500.00	2500.00	670.00	U
chlorobenzene	5.00	5.00	5.00	5.00	Z
ethylbenzene	69.00	190.00	140.00	41.00	U
styrene	23.00	5.00	5.00	5.00	U
mylene (total)	730.00	1700.00	3400.00	510.00	Z

Table B3. (continued)

Compound	Concentration ($\mu\text{g/L}$)				
	T-92	T-101	T-105	T-112	
chloromethane	10.00	10.00	10.00	10.00	U
bromomethane	10.00	10.00	10.00	10.00	U
vinyl chloride	10.00	10.00	10.00	10.00	U
chloroethane	10.00	10.00	10.00	10.00	U
methylene chloride	5.00	5.00	45.00	8.00	B
acetone	5400.00	55.00	3200.00	3600.00	BZ
carbon disulfide	5.00	5.00	0.60	5.00	J
1,1-dichloroethane	5.00	5.00	5.00	5.00	U
1,1-dichloroethane	5.00	5.00	5.00	5.00	U
1,2-dichloroethane (total)	5.00	5.00	5.00	5.00	U
chloroform	5.00	5.00	560.00	1.00	J
1,2-dichloroethane	5.00	5.00	5.00	5.00	U
2-butanone	10.00	10.00	18.00	95.00	B
1,1,1-trichloroethane	5.00	5.00	5.00	5.00	U
carbon tetrachloride	5.00	5.00	5.00	5.00	U
vinyl acetate	10.00	10.00	10.00	10.00	U
bromodichloromethane	5.00	5.00	5.00	5.00	U
1,2-dichloropropane	5.00	5.00	5.00	5.00	U
cis-1,3-dichloropropene	5.00	5.00	5.00	5.00	U
trichloroethene	5.00	5.00	5.00	5.00	U
dibromochloromethane	5.00	5.00	5.00	5.00	U
1,1,2-trichloroethane	5.00	5.00	5.00	5.00	U
benzene	5.00	0.60	12.00	1.00	J
trans-1,3-dichloropropene	5.00	5.00	5.00	5.00	U
bromoform	5.00	5.00	5.00	5.00	U
4-methyl-2-pentanone	10.00	10.00	5.00	5.00	U
2-hexanone	10.00	10.00	10.00	3.00	J
tetrachloroethane	5.00	5.00	5.00	5.00	U
1,1,2,2-tetrachloroethane	5.00	5.00	5.00	5.00	U
toluene	7.00	83.00	3500.00	260.00	Z
chlorobenzene	5.00	5.00	5.00	5.00	U
ethylbenzene	5.00	5.00	130.00	65.00	U
styrene	5.00	5.00	23.00	5.00	U
xylene (total)	5.00	31.00	3000.00	400.00	Z

Table B4. Results of semi-volatile analyses of trench water samples

Compound	Concentration ($\mu\text{g/L}$)				
	T-44	T-63	T-82	T-85	
phenol	12.00				
bis(2-chloroethyl)ether	12.00			11.00	U
2-chlorophenol	12.00	12.00			
1,3-dichlorobenzene	12.00	12.00		11.00	U
1,4-dichlorobenzene	12.00	12.00		11.00	U
benzyl alcohol	12.00	12.00		11.00	U
1,2-dichlorobenzene	12.00	12.00		11.00	U
2-methylphenol	12.00	12.00		11.00	U
bis(2-chloroisopropyl)ether	12.00	12.00		11.00	U
4-methylphenol	12.00	12.00		11.00	U
n-nitroso-di-n-propylamine	12.00	12.00	1200.00	11.00	U
hexachloroethane	12.00	12.00		11.00	U
nitrobenzene	12.00	12.00		11.00	U
isophorone	12.00	12.00		11.00	U
2-nitrophenol	12.00	12.00		11.00	U
2,4-dimethylphenol	12.00	12.00		11.00	U
benzoic acid	58.00	12.00		11.00	U
bis(2-chloroethoxy)methane	12.00	59.00		57.00	U
2,4-dichlorophenol	12.00	12.00		11.00	U
1,2,4-trichlorobenzene	12.00	12.00		11.00	U
naphthalene	12.00	12.00		11.00	U
4-chloroaniline	12.00	5.00		3000.00	U
hexachlorobutadiene	12.00	12.00		11.00	U
4-chloro-3-methylphenol	12.00	12.00		11.00	U
2-methylnaphthalene	12.00	12.00		11.00	U
hexachlorocyclopentadiene	12.00	12.00		11.00	U
2,4,6-trichlorophenol	12.00	12.00		11.00	U
2,4,5-trichlorophenol	58.00	59.00		57.00	U
2-chloronaphthalene	12.00	12.00		11.00	U
2-nitroaniline	58.00	59.00		57.00	U
dimethylphthalate	12.00	12.00		57.00	U
acenaphthylene	12.00	12.00		11.00	U
2,6-dinitrotoluene	12.00	12.00		11.00	U

Qualifiers: B = Detected in blank

E = Exceeds calibration range

J = Below quantification limit, value estimated

U = Below detection limit

Table B4. (continued)

Compound	Concentration ($\mu\text{g/L}$)			
	T-13	T-279	T-288	
3-nitroaniline	67.	71.00	67.	U
acenaphthene	13.	14.00	13.	U
2,4-dinitrophenol	67.	71.00	67.	U
4-nitrophenol	67.	71.00	67.	U
dibenzofuran	13.	14.00	13.	U
2,4-dinitrotoluene	13.	14.00	13.	U
diethylphthalate	12.	14.00	13.	U
4-chlorophenyl-phenylether	13.	14.00	13.	U
fluorene	13.	14.00	13.	U
4-nitroaniline	67.	71.00	67.	U
4,6-dinitro-2-methylphenol	67.	71.00	67.	U
n-nitrosodiphenylamine	13.	14.00	13.	U
4-bromophenyl-phenylether	13.	14.00	13.	U
hexachlorobenzene	13.	14.00	13.	U
pentachlorophenol	67.	71.00	67.	U
phenanthrene	13.	14.00	13.	U
anthracene	13.	14.00	13.	U
di-n-butylphthalate	2.	2.00	2.	JB
fluoranthene	13.	14.00	13.	U
pyrene	13.	14.00	13.	U
butylbenzylphthalate	13.	14.00	13.	U
3,3'-dichlorobenzidine	27.	29.00	27.	U
benzo(a)anthracene	13.	14.00	13.	U
chrysene	13.	14.00	13.	U
bis(2-ethylhexyl)phthalate	13.	14.00	13.	U
di-n-octylphthalate	13.	14.00	13.	U
benzo(b)fluoranthene	13.	14.00	13.	U
benzo(k)fluoranthene	13.	14.00	13.	U
benzo(a)pyrene	13.	14.00	13.	U
indeno(1,2,3-cd)pyrene	13.	14.00	13.	U
dibenz(a,h)anthracene	13.	14.00	13.	U
benzo(g,h,i)perylene	13.	14.00	13.	U

Table B4. (continued)

Compound	Concentration ($\mu\text{g/L}$)							
	T-180	T-237	T-318	T-329				
3-nitroaniline	60.00	57.00	60.00	60.00	U			U
acenaphthene	12.00	11.00	12.00	12.00	U			U
2,4-dinitrophenol	60.00	57.00	60.00	60.00	U			U
4-nitrophenol	60.00	57.00	60.00	60.00	U			U
dibenzofuran	12.00	11.00	12.00	12.00	U			U
2,4-dinitrotoluene	12.00	11.00	12.00	12.00	U			U
diethylphthalate	12.00	11.00	12.00	12.00	U			U
4-chlorophenyl-phenylether	12.00	11.00	12.00	12.00	U			U
fluorene	12.00	11.00	12.00	12.00	U			U
4-nitroaniline	60.00	57.00	60.00	60.00	U			U
4,6-dinitro-2-methylphenol	60.00	57.00	60.00	60.00	U			U
n-nitrosodiphenylamine	12.00	11.00	12.00	12.00	U			U
4-bromophenyl-phenylether	12.00	11.00	12.00	12.00	U			U
hexachlorobenzene	12.00	11.00	12.00	12.00	U			U
pentachlorophenol	60.00	57.00	60.00	60.00	U			U
phenanthrene	12.00	11.00	12.00	12.00	U			U
anthracene	12.00	11.00	12.00	12.00	U			U
di-n-butylphthalate	12.00	11.00	12.00	12.00	U			U
fluoranthene	12.00	11.00	12.00	12.00	U			U
pyrene	12.00	11.00	12.00	12.00	U			U
butylbenzylphthalate	12.00	11.00	12.00	12.00	U			U
3,3'-dichlorobenzidine	24.00	23.00	24.00	24.00	U			U
benzo(a)anthracene	12.00	11.00	12.00	12.00	U			U
chrysene	12.00	11.00	12.00	12.00	U			U
bis(2-ethylhexyl)phthalate	12.00	11.00	12.00	12.00	U			U
di-n-octylphthalate	12.00	11.00	12.00	12.00	U			U
benzo(b)fluoranthene	12.00	11.00	12.00	12.00	U			U
benzo(k)fluoranthene	12.00	11.00	12.00	12.00	U			U
benzo(a)pyrene	12.00	11.00	12.00	12.00	U			U
indeno(1,2,3-cd)pyrene	12.00	11.00	12.00	12.00	U			U
dibenz(a,h)anthracene	12.00	11.00	12.00	12.00	U			U
benzo(g,h,i)perylene	12.00	11.00	12.00	12.00	U			U

Table B4. (continued)

Compound	Concentration ($\mu\text{g/L}$)					
	T-92	T-101	T-105	T-112		
3-nitroaniline	58.00	59.00	57.00	57.00	U	U
acenaphthene	12.00	12.00	11.00	11.00	U	U
2,4-dinitrophenol	58.00	59.00	57.00	57.00	U	U
4-nitrophenol	58.00	59.00	57.00	57.00	U	U
dibenzofuran	12.00	12.00	11.00	11.00	U	U
2,4-dinitrotoluene	12.00	12.00	11.00	11.00	U	U
diethylphthalate	12.00	12.00	11.00	11.00	U	U
4-chlorophenyl-phenylether	12.00	12.00	11.00	11.00	U	U
fluorene	12.00	12.00	11.00	11.00	U	U
4-nitroaniline	58.00	59.00	57.00	57.00	U	U
4,6-dinitro-2-methylphenol	58.00	59.00	57.00	57.00	U	U
n-nitrosodiphenylamine	12.00	12.00	11.00	11.00	U	U
4-bromophenyl-phenylether	12.00	12.00	11.00	11.00	U	U
hexachlorobenzene	12.00	12.00	11.00	11.00	U	U
pentachlorophenol	58.00	59.00	57.00	57.00	U	U
phenanthrene	12.00	12.00	11.00	11.00	U	U
anthracene	12.00	12.00	11.00	11.00	U	U
di-n-butylphthalate	12.00	12.00	11.00	11.00	U	U
fluoranthene	12.00	12.00	11.00	11.00	U	U
pyrene	12.00	12.00	11.00	11.00	U	U
butylbenzylphthalate	12.00	12.00	11.00	11.00	U	U
3,3'-dichlorobenzidine	23.00	24.00	23.00	23.00	U	U
benzo(a)anthracene	12.00	12.00	11.00	11.00	U	U
chrysene	12.00	12.00	11.00	11.00	U	U
bis(2-ethylhexyl)phthalate	12.00	12.00	11.00	11.00	U	U
di-n-octylphthalate	12.00	12.00	11.00	11.00	U	U
benzo(b)fluoranthene	12.00	12.00	11.00	11.00	U	U
benzo(k)fluoranthene	12.00	12.00	11.00	11.00	U	U
benzo(a)pyrene	12.00	12.00	11.00	11.00	U	U
indeno(1,2,3-cd)pyrene	12.00	12.00	11.00	11.00	U	U
dibenz(a,h)anthracene	12.00	12.00	11.00	11.00	U	U
benzo(g,h,i)perylene	12.00	12.00	11.00	11.00	U	U

Table B4. (continued)

Compound	Concentration ($\mu\text{g/L}$)									
	T-44	T-63	T-82	T-85						
3-nitroaniline	50.00	50.00	62.00	57.00	U	U	U	U	U	U
acenaphthene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
2,4-dinitrophenol	50.00	50.00	62.00	57.00	U	U	U	U	U	U
4-nitrophenol	50.00	50.00	62.00	57.00	U	U	U	U	U	U
dibenzofuran	10.00	10.00	12.00	11.00	U	U	U	U	U	U
2,4-dinitrotoluene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
diethylphthalate	10.00	10.00	12.00	11.00	U	U	U	U	U	U
4-chlorophenyl-phenylether	10.00	10.00	12.00	11.00	U	U	U	U	U	U
fluorene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
4-nitroaniline	50.00	50.00	62.00	57.00	U	U	U	U	U	U
4,6-dinitro-2-methylphenol	50.00	50.00	62.00	57.00	U	U	U	U	U	U
n-nitrosodiphenylamine	10.00	10.00	12.00	11.00	U	U	U	U	U	U
4-bromophenyl-phenylether	10.00	10.00	12.00	11.00	U	U	U	U	U	U
hexachlorobenzene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
pentachlorophenol	50.00	50.00	62.00	57.00	U	U	U	U	U	U
phenanthrene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
anthracene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
di-n-butylphthalate	10.00	10.00	12.00	11.00	U	U	U	U	U	U
fluoranthene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
pyrene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
butylbenzylphthalate	10.00	10.00	12.00	11.00	U	U	U	U	U	U
3,3'-dichlorobenzidine	20.00	20.00	25.00	23.00	U	U	U	U	U	U
benzo(a)anthracene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
chrysene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
bis(2-ethylhexyl)phthalate	10.00	10.00	12.00	11.00	U	U	U	U	U	U
di-n-octylphthalate	10.00	10.00	12.00	11.00	U	U	U	U	U	U
benzo(b)fluoranthene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
benzo(k)fluoranthene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
benzo(a)pyrene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
indeno(1,2,3-cd)pyrene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
dibenz(a,h)anthracene	10.00	10.00	12.00	11.00	U	U	U	U	U	U
benzo(g,h,i)perylene	10.00	10.00	12.00	11.00	U	U	U	U	U	U

Table B4. (continued)

Compound	Concentration ($\mu\text{g/L}$)			
	T-13	T-279	T-288	
Phenol	360.	38.00	2.	J
Bis(2-chloroethyl)ether	13.	14.00	13.	U
2-chlorophenol	13.	14.00	13.	U
1,3-dichlorobenzene	13.	14.00	13.	U
1,4-dichlorobenzene	13.	14.00	13.	U
benzyl alcohol	13.	14.00	13.	U
1,2-dichlorobenzene	13.	14.00	13.	U
2-methylphenol	46.	14.00	13.	U
Bis(2-chloroisopropyl)ether	13.	64.00	16.	U
4-methylphenol	1400.	14.00	13.	U
n-nitroso-di-n-propylamine	13.	120.00	25.	U
hexachloroethane	13.	14.00	13.	U
nitrobenzene	13.	14.00	13.	U
isophorone	13.	14.00	13.	U
2-nitrophenol	13.	14.00	13.	U
2,4-dimethylphenol	320.	14.00	13.	U
benzoic acid	300.	27.00	17.	U
Bis(2-chloroethoxy)methane	13.	110.00	10.	J
2,4-dichlorophenol	13.	14.00	13.	U
1,2,4-trichlorobenzene	13.	14.00	13.	U
naphthalene	13.	14.00	13.	U
4-chloroaniline	13.	14.00	57.	U
hexachlorobutadiene	13.	14.00	13.	U
4-chloro-3-methylphenol	13.	14.00	13.	U
2-methylnaphthalene	13.	14.00	13.	U
hexachlorocyclopentadiene	13.	14.00	13.	U
2,4,6-trichlorophenol	13.	14.00	13.	U
2,4,5-trichlorophenol	67.	14.00	13.	U
2-chloronaphthalene	13.	71.00	67.	U
2-nitroaniline	67.	14.00	13.	U
dimethylphthalate	13.	71.00	67.	U
acenaphthylene	13.	14.00	13.	U
2,6-dinitrotoluene	13.	14.00	13.	U

Table B4. (continued)

Compound	Concentration (µg/L)				
	T-180	T-237	T-318	T-329	
Phenol					
bis(2-chloroethyl)ether	12.00	11.00	12.00	40.00	
2-chlorophenol	12.00	11.00	12.00	12.00	U
1,3-dichlorobenzene	12.00	11.00	12.00	12.00	U
1,4-dichlorobenzene	12.00	11.00	12.00	12.00	U
benzyl alcohol	12.00	11.00	12.00	12.00	U
1,2-dichlorobenzene	12.00	11.00	12.00	12.00	U
2-methylphenol	15.00	11.00	12.00	12.00	U
bis(2-chloroisopropyl)ether	12.00	11.00	12.00	12.00	U
4-methylphenol	16.00	11.00	12.00	12.00	U
n-nitroso-di-n-propylamine	12.00	11.00	12.00	12.00	U
hexachloroethane	12.00	11.00	12.00	600.00	U
nitrobenzene	12.00	11.00	12.00	12.00	U
isophorone	12.00	11.00	12.00	12.00	U
2-nitrophenol	12.00	11.00	12.00	12.00	U
2,4-dimethylphenol	12.00	11.00	12.00	12.00	U
benzoic acid	400.00	20.00	20.00	12.00	U
bis(2-chloroethoxy)methane	12.00	57.00	17.00	60.00	U
2,4-dichlorophenol	12.00	11.00	12.00	12.00	U
1,2,4-trichlorobenzene	12.00	11.00	12.00	12.00	U
naphthalene	3600.00	11.00	12.00	12.00	U
4-chloroaniline	12.00	240.00	760.00	170.00	U
hexachlorobutadiene	12.00	11.00	12.00	12.00	U
4-chloro-3-methylphenol	12.00	11.00	12.00	12.00	U
2-methylnaphthalene	24.00	11.00	12.00	12.00	U
hexachlorocyclopentadiene	12.00	11.00	12.00	12.00	U
2,4,6-trichlorophenol	12.00	11.00	12.00	12.00	U
2,4,5-trichlorophenol	60.00	11.00	12.00	12.00	U
2-chloronaphthalene	12.00	57.00	60.00	60.00	U
2-nitroaniline	60.00	11.00	12.00	12.00	U
dimethylphthalate	12.00	57.00	60.00	60.00	U
acenaphthylene	12.00	11.00	12.00	12.00	U
2,6-dinitrotoluene	12.00	11.00	12.00	12.00	U

Table B4. (continued)

Compound	Concentration ($\mu\text{g/L}$)					
	T-92	T-101	T-105	T-112		
Phenol	10.00	10.00	12.00	19.00		
bis(2-chloroethyl)ether	10.00	10.00	12.00	11.00		U
2-chlorophenol	10.00	10.00	12.00	11.00		U
1,3-dichlorobenzene	10.00	10.00	12.00	11.00		U
1,4-dichlorobenzene	10.00	10.00	12.00	11.00		U
benzyl alcohol	10.00	10.00	12.00	11.00		U
1,2-dichlorobenzene	10.00	10.00	12.00	11.00		U
2-methylphenol	10.00	10.00	12.00	11.00		U
bis(2-chloroisopropyl)ether	10.00	10.00	12.00	11.00		U
4-methylphenol	10.00	10.00	12.00	11.00		U
n-nitroso-di-n-propylamine	10.00	10.00	12.00	11.00		U
hexachloroethane	10.00	10.00	12.00	11.00		U
nitrobenzene	10.00	10.00	12.00	11.00		U
isophorone	10.00	10.00	12.00	11.00		U
2-nitrophenol	10.00	10.00	12.00	11.00		U
2,4-dimethylphenol	10.00	10.00	12.00	11.00		U
benzoic acid	50.00	10.00	12.00	11.00		U
bis(2-chloroethoxy)methane	10.00	50.00	62.00	57.00		U
2,4-dichlorophenol	10.00	10.00	12.00	11.00		U
1,2,4-trichlorobenzene	10.00	10.00	12.00	11.00		U
naphthalene	270.00	10.00	12.00	11.00		U
4-chloroaniline	10.00	10.00	12.00	830.00		U
hexachlorobutadiene	10.00	10.00	12.00	11.00		U
4-chloro-3-methylphenol	10.00	10.00	12.00	11.00		U
2-methylnaphthalene	10.00	10.00	12.00	11.00		U
hexachlorocyclopentadiene	10.00	10.00	12.00	11.00		U
2,4,6-trichlorophenol	10.00	10.00	12.00	11.00		U
2,4,5-trichlorophenol	50.00	50.00	62.00	11.00		U
2-chloronaphthalene	10.00	10.00	12.00	57.00		U
2-nitroaniline	50.00	50.00	62.00	11.00		U
dimethylphthalate	10.00	10.00	12.00	57.00		U
acenaphthylene	10.00	10.00	12.00	11.00		U
2,6-dinitrotoluene	10.00	10.00	12.00	11.00		U

Appendix C

**RESULTS OF VOLATILE AND
SEMIVOLATILE ANALYSES OF
INITIAL TRENCH WATER SAMPLES
NOVEMBER 10, 1989**

Table C1. Results of volatiles analyses of initial trench water samples

Compound	Concentration ($\mu\text{g/L}$)			Qualifiers
	T-13	T-16*	T-85	
chloromethane	250.	U	250.	U
bromomethane	250.	U	250.	U
vinyl chloride	250.	U	250.	B = Detected in blank.
chloroethane	250.	U	250.	U
methylene chloride	72.	JB	250.	E = Exceeds calibration
acetone	180.	JB	40.	JB
carbon disulfide	130.	U	260.	B
1,1-dichloroethene	130.	U	130.	U
1,1-dichloroethane	130.	U	130.	J = Below quantification limit,
1,2-dichloroethene (total)	130.	U	130.	value estimated.
chloroform	130.	U	130.	U = Below detection limit.
1,2-dichloroethane	130.	U	130.	U
2-butanone	250.	U	130.	U
1,1,1-trichloroethane	130.	U	250.	U
carbon tetrachloride	130.	U	130.	U
vinyl acetate	250.	U	130.	U
bromodichloromethane	130.	U	250.	U
1,2-dichloropropane	130.	U	130.	U
cis-1,3-dichloropropene	130.	U	130.	U
trichloroethene	130.	U	130.	U
dibromochloromethane	130.	U	130.	U
1,1,2-trichloroethane	130.	U	130.	U
benzene	250.	U	130.	U
trans-1,3-dichloropropene	130.	U	130.	U
bromoform	130.	U	130.	U
4-methyl-2-pentanone	250.	U	130.	U
2-hexanone	250.	U	250.	U
tetrachloroethene	130.	U	250.	U
1,1,2,2-tetrachloroethane	130.	U	130.	U
toluene	6700.	E	130.	U
chlorobenzene	130.	U	19000.	E
ethylbenzene	3200.	U	130.	U
styrene	130.	U	530.	U
xylene (total)	26000.	E	130.	U
			9800.	E

* Sampled by Brian Spalding, Environmental Sciences Division, Oak Ridge National Laboratory.

Table C1 (continued)

Compound	Concentration ($\mu\text{g/L}$)			
	T-105	T-299	T-288	T-318
chloromethane	250.	U	250.	250.
bromomethane	250.	U	250.	250.
vinyl chloride	250.	U	250.	250.
chloroethane	250.	U	250.	250.
methylene chloride	2000.	B	36.	47.
acetone	440.	B	180.	290.
carbon disulfide	130.	U	130.	130.
1,1-dichloroethene	130.	U	130.	130.
1,1-dichloroethane	130.	U	130.	130.
1,2-dichloroethene (total)	130.	U	130.	130.
chloroform	4200.	U	130.	130.
1,2-dichloroethane	130.	U	130.	130.
2-butanone	250.	U	250.	250.
1,1,1-trichloroethane	130.	U	130.	130.
carbon tetrachloride	130.	U	130.	130.
vinyl acetate	250.	U	250.	250.
bromodichloromethane	130.	U	130.	130.
1,2-dichloropropane	130.	U	130.	130.
cis-1,3-dichloropropene	130.	U	130.	130.
trichloroethene	130.	U	130.	130.
dibromochloromethane	130.	U	130.	130.
1,1,2-trichloroethane	130.	U	130.	130.
benzene	88.	J	130.	130.
trans-1,3-dichloropropene	130.	U	130.	130.
bromoform	130.	U	130.	130.
4-methyl-2-pentanone	250.	U	250.	250.
2-hexanone	250.	U	250.	250.
tetrachloroethene	130.	U	130.	130.
1,1,2,2-tetrachloroethane	130.	U	130.	130.
toluene	76000.	E	9300.	7800.
chlorobenzene	130.	U	130.	130.
ethylbenzene	570.	U	190.	160.
styrene	130.	U	130.	130.
xylene (total)	13000.	E	2100.	7100.

Table C2. Results of semi-volatile analyses of initial trench water samples

Compound	Concentration ($\mu\text{g/L}$)			Qualifiers
	T-13	T-16*	T-85	
Phenol	130.00	18.	17.00	
bis(2-chloroethyl)ether	12.00	U	12.00	B = Detected in blank
2-chlorophenol	12.00	U	12.00	U
1,3-dichlorobenzene	12.00	U	12.00	E = Exceed calibration range.
1,4-dichlorobenzene	12.00	U	12.00	U
benzyl alcohol	12.00	U	12.00	J = Below quantification limit, value estimated.
1,2-dichlorobenzene	12.00	U	12.00	U
2-methylphenol	22.00	U	20.00	U
bis(2-chloroisopropyl)ether	12.00	U	12.00	U
4-methylphenol	1400.00	U	370.00	U
n-nitroso-di-n-propylamine	12.00	U	12.00	U
hexachloroethane	12.00	U	12.00	U
nitrobenzene	12.00	U	12.00	U
isophorone	12.00	U	12.00	U
2-nitrophenol	12.00	U	12.00	U
2,4-dimethylphenol	84.00	U	15.00	U
benzoic acid	61.00	U	230.00	
bis(2-chloroethoxy)methane	12.00	U	12.00	U
2,4-dichlorophenol	12.00	U	12.00	U
1,2,4-trichlorobenzene	12.00	U	12.00	U
naphthalene	1400.00	U	870.00	E
4-chloroaniline	12.00	U	12.00	U
hexachlorobutadiene	12.00	U	12.00	U
4-chloro-3-methylphenol	12.00	U	12.00	U
2-methylnaphthalene	1.00	J	0.80	J
hexachlorocyclopentadiene	12.00	U	12.00	U
2,4,6-trichlorophenol	12.00	U	12.00	U
2,4,5-trichlorophenol	61.00	U	62.00	U
2-chloronaphthalene	12.00	U	12.00	U
2-nitroaniline	61.00	U	62.00	U
dimethylphthalate	12.00	U	12.00	U
acenaphthylene	12.00	U	12.00	U
2,6-dinitrotoluene	12.00	U	12.00	U

* Sampled by Brian Spalding, Environmental Sciences Division, Oak Ridge National Laboratory.

Table C2. (continued)

Compound	Concentration ($\mu\text{g/L}$)			
	T-105	T-279	T-288	T-318
phenol	560.00			
bis(2-chloroethyl)ether	13.00	E	13.	34.00
2-chlorophenol	13.00	U	13.	12.00
1,3-dichlorobenzene	13.00	U	13.	12.00
1,4-dichlorobenzene	13.00	U	13.	12.00
benzyl alcohol	13.00	U	13.	12.00
1,2-dichlorobenzene	13.00	U	13.	12.00
2-methylphenol	220.00	U	13.	12.00
bis(2-chloroisopropyl)ether	13.00	U	13.	12.00
4-methylphenol	3800.00	U	13.	22.00
n-nitroso-di-n-propylamine	13.00	E	13.	12.00
hexachloroethane	13.00	U	13.	530.00
nitrobenzene	13.00	U	13.	12.00
isophorone	13.00	U	13.	12.00
2-nitrophenol	13.00	U	13.	12.00
2,4-dimethylphenol	13.00	U	13.	12.00
benzoic acid	210.00	U	13.	12.00
bis(2-chloroethoxy)methane	63.00	U	13.	290.00
2,4-dichlorophenol	13.00	J	65.	61.00
1,2,4-trichlorobenzene	13.00	U	13.	12.00
naphthalene	13.00	U	13.	12.00
4-chloroaniline	5100.00	U	13.	12.00
hexachlorobutadiene	13.00	E	18.	610.00
4-chloro-3-methylphenol	13.00	U	13.	12.00
2-methylnaphthalene	13.00	U	13.	12.00
hexachlorocyclopentadiene	5.00	J	13.	4.00
2,4,6-trichlorophenol	13.00	U	13.	12.00
2,4,5-trichlorophenol	63.00	U	13.	12.00
2-chloronaphthalene	13.00	U	65.	61.00
2-nitroaniline	63.00	U	13.	12.00
dimethylphthalate	13.00	U	65.	61.00
acenaphthylene	13.00	U	13.	12.00
2,6-dinitrotoluene	13.00	U	13.	12.00
		U	13.	12.00

Table C2 (continued)

Compound	Concentration ($\mu\text{g/L}$)		
	T-13	T-16	T-85
3-nitroaniline	61.00	U	62.00
acenaphthene	12.00	U	12.00
2,4-dinitrophenol	61.00	U	62.00
4-nitrophenol	61.00	U	62.00
dibenzofuran	12.00	U	12.00
2,4-dinitrotoluene	12.00	U	12.00
diethylphthalate	12.00	U	4.00
4-chlorophenyl-phenylether	12.00	U	12.00
fluorene	12.00	U	12.00
4-nitroaniline	61.00	U	62.00
4,6-dinitro-2-methylphenol	61.00	U	62.00
n-nitrosodiphenylamine	12.00	U	12.00
4-bromophenyl-phenylether	12.00	U	12.00
hexachlorobenzene	12.00	U	12.00
pentachlorophenol	61.00	U	62.00
phenanthrene	12.00	U	3.00
anthracene	12.00	U	12.00
di-n-butylphthalate	12.00	U	12.00
fluoranthene	12.00	U	12.00
pyrene	12.00	U	12.00
butylbenzylphthalate	12.00	U	12.00
3,3'-dichlorobenzidine	24.00	U	25.00
benzo(a)anthracene	12.00	U	12.00
chrysene	12.00	U	12.00
bis(2-ethylhexyl)phthalate	12.00	U	3.00
di-n-octylphthalate	12.00	U	12.00
benzo(b)fluoranthene	12.00	U	12.00
benzo(k)fluoranthene	12.00	U	12.00
benzo(a)pyrene	12.00	U	12.00
indeno(1,2,3-cd)pyrene	12.00	U	12.00
dibenz(a,h)anthracene	12.00	U	12.00
benzo(g,h,i)perylene	12.00	U	12.00

Table C2 (continued)

Compound	Concentration ($\mu\text{g/L}$)			
	T-105	T-279	T-288	T-318
3-nitroaniline	63.00	U	63.00	U
acenaphthene	13.00	U	13.00	61.00
2,4-dinitrophenol	63.00	U	63.00	12.00
4-nitrophenol	63.00	U	63.00	61.00
dibenzofuran	13.00	U	63.00	61.00
2,4-dinitrotoluene	13.00	U	13.00	12.00
diethylphthalate	9.00	J	13.00	12.00
4-chlorophenyl-phenylether	13.00	U	13.00	12.00
fluorene	13.00	U	13.00	12.00
4-nitroaniline	63.00	U	63.00	12.00
4,6-dinitro-2-methylphenol	63.00	U	63.00	61.00
n-nitrosodiphenylamine	13.00	U	13.00	61.00
4-bromophenyl-phenylether	13.00	U	13.00	12.00
hexachlorobenzene	13.00	U	13.00	12.00
pentachlorophenol	63.00	U	13.00	12.00
phenanthrene	13.00	U	63.00	61.00
anthracene	13.00	U	13.00	12.00
di-n-butylphthalate	13.00	U	13.00	12.00
fluoranthene	13.00	U	13.00	12.00
pyrene	13.00	U	13.00	12.00
butylbenzylphthalate	13.00	U	13.00	12.00
3,3'-dichlorobenzidine	25.00	U	25.00	12.00
benzo(a)anthracene	13.00	U	13.00	24.00
chrysene	13.00	U	13.00	12.00
bis(2-ethylhexyl)phthalate	4.00	J	13.00	12.00
di-n-octylphthalate	13.00	U	14.00	12.00
benzo(b)fluoranthene	13.00	U	13.00	12.00
benzo(k)fluoranthene	13.00	U	13.00	12.00
benzo(a)pyrene	13.00	U	13.00	12.00
indeno(1,2,3-cd)pyrene	13.00	U	13.00	12.00
dibenz(a,h)anthracene	12.00	U	13.00	12.00
benzo(g,h,i)perylene	13.00	U	13.00	12.00
			13.00	12.00

Appendix D

**RESULTS OF ANALYSES OF TREATED WATER
FROM TRENCHES T-13, T-16, T-41 AND T-105**

Table D1. Inductively-coupled plasma spectrometric analyses of treated trench water

Element	Concentration (mg/L)			
	T-13	T-16	T-41	T-105
AG	< 5.0E-03	< 5.0E-03	< 5.0E-03	< 5.0E-03
AL	< 3.0E-02	3.9E-01	1.6E-01	2.1E-01
AS	< 5.0E-02	6.7E-02	< 5.0E-02	< 5.0E-02
B	1.3E+00	1.9E-01	1.3E+00	1.4E-01
BA	5.8E-03	2.0E-02	< 2.0E-03	1.3E-02
BE	8.0E-03	< 2.0E-04	7.8E-03	< 2.0E-04
CA	2.5E+01	6.1E+01	1.2E+00	5.3E+01
CD	< 7.0E-03	< 5.0E-03	< 7.0E-03	< 5.0E-03
CO	< 4.0E-03	< 4.0E-03	< 4.0E-03	< 4.0E-03
CR	< 4.0E-03	6.3E-03	< 4.0E-03	9.5E-03
CU	2.8E-01	< 5.0E-03	2.7E-01	< 5.0E-03
FE	4.7E-01	3.5E+00	1.9E-02	1.7E+00
LI	< 1.5E+01	< 1.5E+01	< 1.5E+01	< 1.5E+01
MG	1.9E+01	3.6E+01	1.6E-02	2.1E+01
MN	5.3E-02	1.6E-01	2.3E-02	2.4E-01
MO	< 4.0E-02	< 4.0E-02	< 4.0E-02	< 4.0E-02
NA	9.0E+00	5.9E+00	< 5.0E+00	1.4E+01
NI	< 9.0E-03	< 5.0E-03	< 9.0E-03	< 5.0E-03
P	3.6E+01	4.1E+01	< 3.0E-01	1.9E+01
PB	< 3.0E-02	< 5.0E-02	< 3.0E-02	< 5.0E-02
SB	< 5.0E-02	< 5.0E-02	< 5.0E-02	< 5.0E-02
SE	< 4.0E-02	< 5.0E-02	< 4.0E-02	< 5.0E-02
SI	1.1E+01	1.5E+01	2.8E+00	4.4E+00
SN	< 5.0E-02	< 5.0E-02	< 5.0E-02	< 5.0E-02
SR	1.7E-01	4.1E-01	2.3E-02	3.4E-01
TI	6.8E-02	< 2.0E-02	6.6E-02	< 2.0E-02
V	< 4.0E-03	< 2.0E-03	< 4.0E-03	< 2.0E-03
ZN	1.1E-01	< 5.0E-03	2.2E-02	< 5.0E-03
ZR	< 2.0E-02	< 2.0E-02	< 2.0E-02	< 2.0E-02

Table D2. Results of volatile analyses of treated trench water

Compound	Concentration ($\mu\text{g/L}$)				Qualifiers
	T-13	T-16	T-105		
chloromethane	10.	U	10.	U	
bromomethane	10.	U	10.	U	B = Detected in blank.
vinyl chloride	10.	U	10.	U	
chloroethane	10.	U	10.	U	
methylene chloride	1.	JB	5.	U	J = Below quantification limit, value estimated.
acetone	10.	U	10.	1.	JB
carbon disulfide	5.	U	5.	U	U = Below detection limit.
1,1-dichloroethene	5.	U	5.	U	
1,1-dichloroethane	5.	U	5.	U	
1,2-dichloroethene (total)	5.	U	5.	U	
chloroform	5.	U	5.	U	
1,2-dichloroethane	5.	U	5.	U	
2-butanone	10.	U	10.	U	
1,1,1-trichloroethane	5.	U	5.	U	
carbon tetrachloride	5.	U	5.	U	
vinyl acetate	10.	U	5.	U	
bromodichloromethane	5.	U	5.	U	
1,2-dichloropropane	5.	U	5.	U	
cis-1,3-dichloropropene	5.	U	5.	U	
trichloroethene	5.	U	5.	U	
dibromochloromethane	5.	U	5.	U	
1,1,2-trichloroethane	5.	U	5.	U	
benzene	5.	U	5.	U	
trans-1,3-dichloropropene	5.	U	5.	U	
bromoform	5.	U	5.	U	
4-methyl-2-pentanone	10.	U	5.	U	
2-hexanone	10.	U	10.	U	
tetrachloroethane	5.	U	10.	U	
1,1,2,2-tetrachloroethane	5.	U	5.	U	
toluene	5.	U	5.	U	
chlorobenzene	5.	U	5.	U	
ethylbenzene	5.	U	5.	U	
styrene	5.	U	5.	U	
xylene (total)	5.	U	5.	U	

Table D3. Results of semi-volatile analyses of treated trench water

Compound	Concentration ($\mu\text{g/L}$)			Qualifiers
	T-13	T-16	T-105	
phenol	10.00	U	10.	U
bis(2-chloroethyl)ether	10.00	U	10.	U
2-chlorophenol	10.00	U	10.	U
1,3-dichlorobenzene	10.00	U	10.	U
1,4-dichlorobenzene	10.00	U	10.	U
benzyl alcohol	10.00	U	10.	U
1,2-dichlorobenzene	10.00	U	10.	U
2-methylphenol	10.00	U	10.	U
bis(2-chloroisopropyl)ether	10.00	U	10.	U
4-methylphenol	10.00	U	10.	U
n-nitroso-di-n-propylamine	10.00	U	10.	U
hexachloroethane	10.00	U	10.	U
nitrobenzene	10.00	U	10.	U
isophorone	10.00	U	10.	U
2-nitrophenol	10.00	U	10.	U
2,4-dimethylphenol	10.00	U	10.	U
benzoic acid	50.00	U	10.	U
bis(2-chloroethoxy)methane	10.00	U	51.	U
2,4-dichlorophenol	10.00	U	10.	U
1,2,4-trichlorobenzene	10.00	U	10.	U
naphthalene	10.00	U	10.	U
4-chloroaniline	10.00	U	2.	J
hexachlorobutadiene	10.00	U	10.	U
4-chloro-3-methylphenol	10.00	U	10.	U
2-methylnaphthalene	10.00	U	10.	U
hexachlorocyclopentadiene	10.00	U	10.	U
2,4,6-trichlorophenol	10.00	U	10.	U
2,4,5-trichlorophenol	50.00	U	10.	U
2-chloronaphthalene	10.00	U	51.	U
2-nitroaniline	50.00	U	10.	U
dimethylphthalate	10.00	U	51.	U
acenaphthylene	10.00	U	10.	U
2,6-dinitrotoluene	10.00	U	10.	U

B = Detected in blank.
 J = Below quantifica-
 tion limit, value
 estimated.
 U = Below detection
 limit.

Table D3. (continued)

Compound	Concentration ($\mu\text{g/L}$)			
	T-13	T-16	T-105	
3-nitroaniline	50.00	U	56.	U
acenaphthene	10.00	U	11.	U
2,4-dinitrophenol	50.00	U	56.	U
4-nitrophenol	50.00	U	56.	U
dibenzofuran	10.00	U	11.	U
2,4-dinitrotoluene	10.00	U	11.	U
diethylphthalate	10.00	U	1.	JB
4-chlorophenyl-phenylether	10.00	U	11.	U
fluorene	10.00	U	11.	U
4-nitroaniline	50.00	U	56.	U
4,6-dinitro-2-methylphenol	50.00	U	56.	U
n-nitrosodiphenylamine (1)	10.00	U	11.	U
4-bromophenyl-phenylether	10.00	U	11.	U
hexachlorobenzene	10.00	U	11.	U
pentachlorophenol	50.00	U	56.	U
phenanthrene	10.00	U	11.	U
anthracene	10.00	U	11.	U
di-n-butylphthalate	10.00	U	11.	U
fluoranthene	10.00	U	11.	U
pyrene	10.00	U	11.	U
butylbenzylphthalate	10.00	U	11.	U
3,3'-dichlorobenzidine	20.00	U	22.	U
benzo(a)anthracene	10.00	U	11.	U
chrysene	10.00	U	11.	U
bis(2-ethylhexyl)phthalate	10.00	U	27.	U
di-n-octylphthalate	10.00	U	11.	U
benzo(b)fluoranthene	10.00	U	11.	U
benzo(k)fluoranthene	10.00	U	11.	U
benzo(a)pyrene	10.00	U	11.	U
indeno(1,2,3-cd)pyrene	10.00	U	11.	U
dibenz(a,h)anthracene	10.00	U	11.	U
benzo(g,h,i)perylene	10.00	U	11.	U

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