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August 23, 2004

Mr. Eric Nold
On-Scene Coordinator
U.S. Environmental Protection Agency
Region VII
901 North 5th Street
Kansas City, Kansas 66101

RE: Sentinel Wood Treating Site Alternate Time-Critical Removal Action Work Plan

Dear Mr. Nold

I am submitting a revised Alternate Time-Critical Removal Action Work Plan incorporating the supplemental changes to the plan that were previously submitted to you and incorporating your comments from the previously submitted Work Plan.

We have expanded the bioremediation treatment from one to two active growing seasons per batch. This change is reflected in the Plan's Schedule. Overall this allows completion of the project in 2011.

Some PAHs greater than the Missouri CALM and EPA PRGs, were reported in some of the sediment samples taken along the length of the creek. (MDNR Report of September 9, 2002 Table 12). PAH are formed during the incomplete combustion of coal or oil based products. Coal Tar and petroleum coke are byproducts from the coke and the oil distillation production processes. These byproducts are beneficially used in the manufacture of asphalts ,shingles, and other tar based products. Some wood treaters previously used coal tar or creosotes in the preservation of railroad ties, telephone poles and other wood products. Sentinel throughout its history did not use coal tar or creosote in its treatment process. Soil borings taken on the Sentinel site Table 1 of the above referenced report confirm this and do not show any correlation to the PAHs in the sediment samples taken in the creek. The background sample take upstream from the site indicates PAH greater than the CALM and PRG for BαP.

PAHs are know to leach from asphalt roads and parking lots and are found in their runoff. Samples down stream of the treatment plant do indicate PAHs but the sampling points are also down stream of major asphalt parking lots and a major highway. In our sampling plan we do not include PAH sampling of the excavations or remediated soils from the bioremediation treatment cells.

References were made in the comments as to why we were not shipping more material off-site. My understanding of the waste minimization rules is that a generator must certify under penalty of law that there is no feasible way to reuse, recycle or treat on-site before signing a manifest to ship hazardous waste off-site. That is not the case with the material at Sentinel. In addition, better characterization of the actual material to be shipped off-site must be done after excavation so that an application for approval can be submitted to the TSD's. There is some doubt that we can gain approval of the highly contaminated material, but we will try.

We believe the microbes on site are capable of breaking down 1000 ppm PCP. From Reference 7 in the plan we know unacclimatized microbes are unable to survive in a 2000-ppm environment, however acclimatized microbes are capable of breakdown of PCP of 2000 ppm. Unacclimatized microbes are able to grow in a 200 ppm PCP environment. The onsite soils along the east road which we plan to remediate and use as inoculants to the bioremediation treatment cell have existing microbes which have already been acclimatized to PCP in the 400-500 ppm range. This inoculant is to be used for remediation of the soils from the 110 ppm isopleth by the old treatment plant, whose average concentration is estimated to be 450 ppm. This soil concentration is excluding the additions of sawdust, which will bring starting soil concentrations into the 300 ppm range.

While I understand that blending to homogenize or dilute concentrations to below action levels is not acceptable, blending and diluting waste material to meet the requirements of treatment technologies occurs routinely in the industry. Incinerator operators blend to increase or decrease BTU, chlorine, benzene and various other parameters to meet the specifications of the technology. Landfills and other facilities also operate this way to deal with physical and chemical limits. I do not understand the concern with blending PCP contaminated soils to create a more homogenous material and to reduce PCP levels to the tolerance of the microbes. To blend and dilute is not a solution, and should be allowed if the purpose is to meet the specifications of the technology and the dilution by itself does not result in a reduction of contaminate concentrations to below action levels.

You imply in your comments that the third lagoon has the highest concentration of PCP. I believe that the MDNR Figure 6 identifies the Former Lagoon Area as only the western and central lagoons. In comparing the Tetra Tech Figure 1 drawings of the lagoon outlines and comparing the borehole locations of Figure 6 and Figure 1 it is clear that the MNDR Figure 6 Former Lagoon Area hash marks do not encompass the eastern lagoon and the highest concentrations of PCP are clearly in the central lagoon with the eastern lagoon containing relatively little PCP contaminate. We have overlaid the Tetra Tech lagoon areas on Figures 2 to better illustrate where the lagoons lay.

I believe we have included all the comments in the work plan. Should you require clarification please contact me promptly so I can quickly answer your concern to expeditiously move forward with the project.

Sincerely,

Fred Lafser

Fred A. Lafser
President

CC: Don Farris
David Shorr
Pia Capell

ALTERNATE TIME-CRITICAL REMOVAL ACTION WORK PLAN
Sentinel Wood Treating Site
Ava, Missouri

Prepared for:

SENTINEL WOOD TREATING SITE

Ava, Missouri

October 3, 2003
Revised August 25, 2004

LAFSER & ASSOCIATES, INC.
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1 INTRODUCTION

The Sentinel Wood Treating Site (SWTS) located in Ava, Missouri, is the subject of an Administrative Order on Consent (Order) entered voluntarily by the USEPA, the Missouri Department of Natural Resources (MDNR), and Sentinel Industries, Inc. (Sentinel). This Alternate Time-Critical Removal Action Work Plan is submitted as the logical extension to the site characterization plan to meet the requirements of the Order. Sentinel has agreed to take the lead in this effort and the company retained the services of Lafser and Associates, Inc. to prepare the required plans. This Plan is submitted to meet the requirements of the Order for remediation. The Plan is based on data from the USEPA, MDNR, Sentinel, Kingston, and Emerson that is incorporated in the Sentinel Removal Assessment Report and provides the basis along with the concentration levels of pentachlorophenol (PCP), and dioxin equivalents draft action levels[1] for the remediation treatment technologies suggested.

1.1 Site Location

The Sentinel Wood Treating site is located at 412 NW 12TH Avenue in Ava, Douglas County, Missouri. The legal description is the W ½ of the NE ¼ of the NW ¼ sec. 11, T. 26 N., R. 16 W. as noted on the Ava, Missouri Quadrangle 7.5 Minute Topographic map. The geographic coordinates are Latitude +36.9655, Longitude -92.6601. The site is approximately ½ mile east of the junction of Highways 14 and 5, on the north side of NW 12TH Avenue.

1.2 Site Description and Operational History

The history of this site has previously been covered in the Removal Assessment Work Plan, March 10, 2002.

1.3 Project Management

The site is owned by Sentinel Industries, Inc. The company will provide access and site security. Mr. Don Farris, President, and employee Jerry Hadeen will provide assistance with the implementation of the Work Plan. They will also assist with the ongoing management of the groundwater treatment program, oxidative cut-off barriers, and the bioremediation land farm.

The Project Manager will be Fred Lafser, President, Lafser & Associates, Inc. He will report directly to Sentinel Industries, Inc. and provide liaison to EPA and MDNR. Roger Riemann, Sr. Environmental Scientist for Lafser & Associates, Inc. will serve as Quality Assurance Officer and Site Safety

[1] USEPA Region VII, Eric Nold's Letter of September 4, 2003 to Fred Lafser from comment 25.

Officer. Brian Hart, Site Manager for Lafser & Associates, Inc. will serve as Field Coordinator. Philip Environmental Services Corporation will provide geological engineering services, and geologic interpretation. Mr. Dale Markley will be the Philip subcontract manager. The excavation contractor or construction contractor has not been retained. Prior to excavation of contaminated soils, Sentinel employees may provide some of the labor for building construction.

- Groundwater generally flows in a southwesterly direction on the east side of the creek and to the southeast on the west side of the creek expressed in Figure 7 "Proposed Remediation Excavation and Trench Locations in Former Wood Treatment Area". Groundwater elevations in piezometers (PZ-15 and PZ-16) range from 5 to 7 feet below ground surface (bgs); Borehole refusal, which may be indicative of bedrock, was approximately 7 to 9 feet bgs in these two piezometers. Generally, site bedrock lays approximately 15 feet bgs or less.
- The site is located in the Ozark Plateau physiographic region of south central Missouri. The geology of the area is dominated by sedimentary carbonate rocks (Jefferson City dolomite) and is characterized by bedrock highs, narrow stream valleys, and karst topography. Surface water flow is generally to the south-southwest towards an unnamed tributary of Prairie Creek. Surface soils above bedrock typically consist of clay with chert fragments. [2]

[2] Geologic Summary of Sentinel Wood Treating Site, Bill Little, Geologist, Environmental Geology section, GSP, GSRAD to Valerie Wilder, Superfund Section, HWP, DEQ. Memorandum,15 pages, September 10,2001

3 CONTAMINATED SOIL VOLUME ESTIMATES

3.1 Cleanup levels

Because cleanup levels for the site have not been finalized, contaminant boundaries, depths, and volume estimates will be based on draft action levels for PCP of 11 parts per million (ppm), 30 ppm and 110 ppm for land use, 1 part per billion (PPB) ground water[3] and dioxin equivalents of 1, 5, and 20 ppb for soils.[1] These draft action levels were provided by EPA and were derived from either historical Preliminary Remedial Goals (PRG) tables or have been used at other wood treater sites in Region VII. Missouri's drinking water level for 2,3,7,8 tetrachloro-p-dioxin is 0.03 parts per trillion.[4] Since various media and degrees of PCP concentrations exist on site, technologies for sludge, soil and sediment along with treatment of ground water from this site are considered relevant. The technologies that are proposed are consistent with those in the EPA's Presumptive Remedies Document for wood treater sites or have been shown effective by the EPA.[5] Studies have shown that the acclimated white-rot basidiomycete is capable of breaking down PCP concentrations over 2,000 ppm.[6] We believe that for the bioremediation treatment cell proposed, 1,000 ppm is a feasible ceiling concentration for a batch of material to be treated aerobically.

3.2 Lagoon Area Northwest Part of Site

The contamination in the lagoon area at the northwest border of the property has a total surface area of approximately 29,000 ft^2. The east lagoon was removed and the west and central lagoons were filled/closed with the soils from the east lagoon. The volume of all material, regardless of concentration, in this area is extrapolated from the data to be 8,651 cubic yards, if one assumes the subsurface clay lagoon structures do not exist or that they are saturated with contamination. The design capacity of the two remaining lagoons was less than 1500 cubic yards each, and much of the west lagoon is

[3] Missouri Department of Natural Resources, Cleanup Levels for Missouri, Appendix B. Tier 1 Soil and Groundwater Cleanup Standards, June 29, 2001.
[4] Maximum Synthetic Organic Chemical Contaminate Levels and Monitoring Requirements, Department of Natural Resources, Public Drinking Water Program, 10 CSR 60-4.040, October 31, 2002
[5] Presumptive Remedies: Technology Selection Guide for Wood Treater Sites, USEPA Publication 9360.0-46FS, EPA540-F-93-020, April 1993.
[6] Transformation of high concentrations of chlorophenols by the white-rot basidiomycete *Trametes versicolor* immobilized on nylon mesh, Mohammad R. Sedarati, Tajalli Keshavarz, Alexey A. Leontievsky, Christine S. Evans, Electronic Journal of Biotechnology ISSN: 0717-3458, Vol. 6 No. 2, Issue of August 15, 2003

not contaminated to levels requiring action. The material in the lagoons is scrap lumber, sludge, soil from the lagoon berms, tree sap, and pine tar from the wood treatment process, and other sludge materials from the treatment plant. Based on EPA's sampling data, contained in the Missouri Department of Natural Resources' Report, estimates of soil volumes above 22 ppm, 110 ppm, and 1100 ppm were made.[7] Calculating the best-fit volume for a parabola for 22 ppm or greater isopleths, we estimate a radius of 91 feet to a depth of 12 feet. This resulted in a total volume of 5654 cubic yards of material greater than 22 ppm, which includes the 110-ppm and 1100-ppm soils. For soils greater than 110 ppm and greater than 1100 ppm we estimate 2317 yd^3 and 1148 yd^3 respectively using the isopleths of Figures 2, 3, and 4, MDNR Isopleths at depths 2-4, 6-8, 10-12 feet.

The MDNR boundary identification (Former Lagoon Area) in the Figures 2, 3, & 4 above only include two of the lagoons and does not include the third lagoon, which was not used by Sentinel. By reviewing the 12th Avenue Solvent aerial photo, Ava, MO DOQ 1995, with the sampling points and the three lagoons identified, one can identify borings and see the east lagoon, which includes borings BH-19, BH-14, and BH-19A, and are outside the perimeter identified in the MDNR Figures 2, 3, & 4. Bore hole BH-14 is outside of the boundaries of the center lagoon and shows contamination of 82 ppm at the 2-4 ft interval and diminishes to less than 1 ppm at 6.5 – 8 ft. This is possibly the result of tracking of contamination by the dozer during closure of the center lagoon. BH – 21 is also outside the lagoon boundary to the south. Levels of 400 ppm at 2-4 ft and 34 ppm at 6-8 ft were recorded by EPA. This is the location of the transfer of the sludge from truck to the center lagoon and may be the result of sloppy handling, or, could represent a leak from the hot zone area of BH -17, immediately to the north and inside the lagoon. The areas will be further explored during the excavation of the lagoon material.

Only one data point BH-16, in the west lagoon shows PCP levels above action levels. This is the location of the discharge hose when Sentinel transferred the water zone of the center lagoon to the west lagoon.

The above volume estimates assume a continuous zone of contamination in the lagoon area. Since the lagoons were built as separate "bowl" shaped clay lined facilities, an east-west cross section will show that there is large "triangular" shaped clay zone, which is likely to be only slightly contaminated. For treatment facility design purposes, we will reduce this volume estimate of material above 110-ppm PCP from 2317 to 1,500 cubic yards. If further characterization of the lagoons reveals a need to change, a plan revision will be discussed with EPA and submitted for approval.

[7] Expanded Site Inspection Report, Sentinel Wood Treating Co. Inc. Site, MOD029684438, Missouri Department of Natural Resources, September 9, 2002

Additional treatment capacity can be developer on the east side of the creek if necessary.

Some test data of the lagoon material, is of the actual tar-like "seep" material. If this material is uncovered during excavation, it can be segregated and may qualify for off-site energy recovery at a permitted facility. However, when one characterizes the lagoon further, we believe the homogenized material removed from the lagoons will be well below the 1000 ppm PCP biological treatment limit. Only 5 of 95 samples collected by EPA in the lagoon area exceeded 1000 ppm PCP. Only 5 of 51 samples from inside the lagoon boundary exceeded 1000 ppm PCP, and of these, only one soil sample, 17 A, exceeded 2400 ppm PCP.

3.3 Contaminated roadway soil on east side of creek

Based on the concentrations of PCP in the soils from the sampling trenches across the roads east of the creek isopleth maps were drawn for 11 ppm and 110 ppm concentrations. See Figure 5, Soil Pentachlorophenol Concentrations and Proposed Soil Remediation Locations. The estimated volumes for the east and west roadways at the 11-ppm isopleth are 489 cubic yards (yd^3), and 444 yd^3 respectively. The volumes drop to 89 yd^3 and 355 yd^3 at the 110-ppm isopleth boundary. It is difficult to define isopleths for 30 ppm based on the available data points but the 11-ppm and 30-ppm isopleths are essentially the same area and volume according to the data.

3.4 Former Treatment Plant

Based on the isopleth map Figure 6, Former Wood Treatment Area Isopleths of PCP Soil Concentrations, we believe the soil concentrations of PCP under the floor of the existing warehouse and the former wood treatment building floor are the primary source of the ground water levels of PCP under the parking lot south of the buildings. Additionally, the area along the east side of the former treatment plant, based on the isopleth map, has the highest sources of contamination. This area is against the subsurface retaining wall and is believed to be the primary source of contamination of the creek. The amount of soil estimated to be removed from the area is 320 cubic yards at the 110-ppm boundary taken to bedrock at 10 feet. We have chosen the 110-ppm boundary because we are limited by the amount of space in the bioremediation treatment facility. Soils below the 110-ppm level will be left and treated in place.

A sediment sampling effort was conducted in the creek's box culvert, which runs through the site on the west side of the former treatment plant. Analytical data indicated PCP concentrations up to10-ppm in six dark stained soil areas in the culvert. This is an obvious source of contamination to the

creek waters. The stains are observed to be the result of material coming from the former treatment plant through the joints in the concrete wall and through the steel concrete form ties. This was confirmed visually on two occasions. We estimate approximately 1.25 yd^3 of stained material for removal and placement in the biological treatment cell.

4 SAMPLING AND ANALYTICAL PROCEDURES

Field sampling will be in a manner consistent with approved methods for the collection, preservation, and transport of various media sampled. Laboratory testing will be by Environmetrics, Inc. in St. Louis, Missouri, and Pace Analytical Services, Inc., using methods identified in the amended Quality Assurance Project Plan associated with this Alternate Time-Critical Removal Action Work Plan and the previously developed Removal Assessment Work Plan. The Site Sampling Plan from March 10, 2002 has been expanded and the additions are included in the Site Sampling Plan Addendum, which is submitted concurrently with this plan. In addition to the wells and piezometers currently on site, we will install two new piezometers PZ-17 and PZ-18 along with one shallow bedrock well MW-4 drilled to 35 feet, cased and screened to collect water samples from the C-Zone as described in the ESC Report Figure 11. Reference footnote 9. It is our intention to install this well in competent bedrock. The piezometers, excavation trenches, down gradient wells, and shallow bedrock well locations are shown in Figures 7, "Proposed Remediation Excavation and Trench Locations" and Figure 8, "Groundwater Pentachlorophenol Concentrations for Down gradient Wells on Merritt Property". The placement of the piezometers will aid in additional evaluation of the in-situ HRC activity.

5 APPROACH FOR REMEDIATION

The locations, concentrations, and physical characteristics of the pentachlorophenol at this site will require various treatment methodologies for reclamation activities. A 40,000 sq ft (100ft X 400ft) covered bioremediation treatment facility using enhanced aerobic digestion for soils will be constructed and operated for five to seven years until soils are treated to below industrial action levels of 30 ppm or less PCP. This facility will be on the west side of the creek. If additional capacity if needed, a similar facility will be constructed on the east side of the creek. The initial development on the west side of the creek will be 100 ft by 200 ft, and is approximately one-half of the completed facility. This will provide capacity for the initial excavation, anticipated in the late summer of 2004. The second half of the west facility will be completed in the winter of 2004-2005, to provide capacity for the second excavation in the spring of 2005.

The excavation activity is planned to occur in four phases, as described below. The schedule is designed to address the areas of greatest risk to public health and environment first. In addition, this will allow the reuse of the treatment facility to minimize the capital required to treat all materials at one time. Thus, the treatment will occur in "batches" with excavation occurring over a period of several years. Each "batch" is anticipated to require two warm weather treatment seasons. When treatment goals are met, the material will be removed and the next phase of material will be excavated and placed in the facility. The Schedule for the excavation and treatment activities for the site is in Section 9. Achievement of treatment goals will determine if the schedule can be accelerated or will require extension.

Phase One: 2004-05. Construction of initial bioremediation treatment facility, development and growth of PCP inoculants, excavation and treatment of the former wood treatment plant soils.

Phase Two: 2005-07. Construction of the second "half" of the bioremediation facility on the west side of the creek and bioremediation of the west road excavations.

Phase Three: 2007-09. Excavation and bioremediation of west lagoon materials and the east road material. If treatment time and capacity become an issue, the need for the additional treatment facility on the east side of the creek will be evaluated.

Phase Four: 2009-11. Excavation and bioremediation of the center lagoon materials.

Phase Five: 2011. Grading and closure of the site.

Activated carbon absorption will be used for treatment of contaminated collected ground waters. Chemical oxidation using potassium permanganate or hydrogen peroxide is proposed for a small highly concentrated confined source in the concrete box sump of the former treatment plant cell. Installation of injection trenches for in-

situ anaerobic digestion using Hydrogen Release Component (HRC)[8], is proposed for inaccessible and areas under pavement. The reuse of recoverable high (> 5000 btu/lb) Btu solids and tars as a supplemental fuel source in an approved/permitted Industrial Boiler may be employed if the material is approved for reuse and not cost-prohibited.

5.1 Preliminary Development

At a public meeting held on the concept of the bioremediation treatment of the pentachlorophenol, a concern was raised about potential odors from trucks of manure proposed to be delivered to the site to establish microbe populations in the bioremediation treatment cell. As a means to mitigate this issue, we plan to develop the organisms necessary for the biodegradation by using current onsite aerobic bacteria in the surface soils along the lower road east of the creek. We will first develop approximately 1000 sq ft of the bioremediation treatment cell to "grow" a sufficient population of bacteria as our inoculants. This will reduce the amount of manure required to only three trucks and minimize the concern of odor in the area.

5.2 Former Treatment Plant

5.2.1 Soils

Based on the isopleth map Figure 6, "Former Wood Treatment Area Isopleths of PCP Soil Concentrations", soil concentrations of PCP above action levels are under the warehouse and former wood treatment building's concrete floors. We believe these to be the primary source of the ground water levels of PCP under the parking lot south of the buildings as well as the source of contamination of the on site creek. Additionally, the data reveals that the area along the east side of the former treatment plant, as shown on the isopleth map, has the highest levels of contamination. The amount of soil estimated to be removed from the area is 320 cubic yards at the 110-ppm boundary taken to bedrock at 10 feet based on a prolate spheroid. The excavation on the west side of the on site creek culvert, Figure 7, will be left open for a period of time for evaluation and a permanent type fence will be installed around the area. We plan to inspect the integrity of the wall and design improvements to prevent contamination from migrating through the wall and into the creek. These plans cannot be formulated until we have a better visual understanding of the situation. We also want to draw ground water into this excavation to encourage movement of water and HRC under the building. This area can then function as a large sump from which water can be pumped and treated with activated carbon. No drain is planned in this area or tie-in to SSD #7 at this time. Any excess waters in the area created by the excavation of

[8] THE USE OF HRC® FOR PCP DEGRADATION, Neil Brown (Ecology and Environment inc.), Fred Nika (Illinois EPA, Springfield), Scott Mullin, Kevin Lapus (Regenesis) Appendix Section E

contaminated soil will be treated through the carbon filter unit. We do plan to backfill and grade the excavation at completion of the project.

5.2.2 Former Treatment Collection Sump

The highly contaminated material (>1000 ppm PCP) that is in the enclosed below grade rectangular concrete sump, near SB15 in Figure 6, will be treated in-place with a chemical oxidant solution such as Hydrogen Peroxide or Potassium Permanganate. The lesser contaminated materials above this zone will be removed and treated, and placed in the biological treatment cell if necessary. Excavated soils below 30-ppm PCP will be stored on site pending EPA approval to not require further action. We have chosen treatment to reduce the PCP levels rather than sending the waste to a hazardous waste landfill. The material will be treated to <30 ppm PCP or it will be removed. HRC is a food source to stimulate anaerobes and the 5000 mg/kg PCP level in the sump is too concentrated for biological treatment, unless it is blended with lower concentration material. The treated soils/sludge will remain in the sump once 30-ppm is achieved. A 2-4 wt percentage feed solution introduced by a vertical recirculation well system will be used to treat the sludge and liquids in the bottom of the tank. Based on DNR SB15 @ 6.5-7' we have calculated the volume of sludge in the bottom of the sump. The sump is approximately 19' X 9' and assuming 6" of sludge, we have 86 ft^3 of material for treatment. After treatment, samples will be taken of the sludge and liquids to verify treatment effectiveness.

5.2.3 Former Treatment Plant Soils

The primary source of PCP contamination to the ground water in the south parking lot is the treatment plant area that is now covered by a concrete floor or concrete pad. Based upon the groundwater well information from the site and the geophysical information contained in the Twelfth Avenue Site Emerson Report[9], ground water flow at the site is from northwest to southeast toward the creek on the west side of the creek, Figure 7. Based on PCP's solubility of 0.001% at 68°F,[5], ground water flow will continue to leach PCP contaminates from soils beneath the concrete unless diverted from this source, treated in-situ, or the source of contamination removed. Excavation of the area is not feasible because it would require the demolition of the warehouse's and department store floors and the concrete pad to the east of the building. The warehouse floor is 24" - 30" thick in some places and the soils beneath are not considered to be the major source of contamination to the ground water in the parking lot samples. Soil boring concentrations range from 2.2 –

[9] Removal Assessment Report for the 12th Avenue Solvent Site, Ava, Missouri: Environmental Strategies Corporation, December 19, 2002.

20 ppm. While removal or treatment due to soil concentration is not necessary to achieve cleanup goals, these levels do contribute to groundwater levels above 1-ppb PCP. In lieu of removal of the contaminate under the floor we will remediate with below grade and down gradient placement of intercepts (Figure 7) to bedrock, filled with Hydrogen Release Compound (HRC) to create an anaerobic environment for in-situ bioremediation as discussed in Section 7.0.

5.2.4 Ground Water Under Parking Lot

Since the ground water currently has residual levels of PCP above 1 ppb, we plan continued pumping of the south sump and treating with activated carbon. until the anaerobic populations in the groundwater zone are well established. We believe this pumping will also maintain a hydraulic gradient to assist ground water movement through the treatment barriers (see Section 7) and bring the nutrient source to the anaerobic populations. We plan to keep the north sump inactive, except as a source of irrigation water for the biological treatment program.

5.3 Contaminated roadway soil on east side of creek

Using the concentrations of PCP in the soils from the sampling trenches across the roads east of the creek, isopleth maps were drawn for 11 ppm and 110 ppm concentrations, Figure 5, Soil Pentachlorophenol Concentrations and Proposed Soil Remediation Locations. The estimated volumes for the east and west roadways at the 11-ppm isopleth are 489 cubic yards yd^3, and 444 yd^3 respectively. From the sampling data available for the road, we would estimate 30-ppm isopleths to be generally along the same contours as the 11 ppm. Contaminated soil greater than 30 ppm PCP will be excavated and placed in the biological treatment cell.

5.4 Lagoon Area Northwest Part of Site

The area of the former lagoons at the northwest border of the property has a total surface area of approximately 29,000 ft^2. The volume of material in the three lined lagoons is estimated to be 8,651 cubic yards. The material is believed to be scrap wood, sludge, soil, tree sap and pine tar from the evacuation process, and other materials from the former treatment plant. Soils greater than 110 ppm PCP will be excavated and moved to the biological treatment cell. We estimate 1500 yd^3 of material will be removed . Remaining material will be evaluated and modification will be prepared to remediate. This could be capping or closure and monitoring in place, on-site treatment using the lagoons as containment, or continued operation of the biological treatment cell.

The lagoons contain chunks of contaminated wood scrap and wood saps and tars, which make the bioremediation of these wastes difficult unless the material is shredded to increase surface area. Since this material is currently not in a form suitable for land reclamation, we propose to separate and ship the waste to Missouri Fuels and Recycling for use a fuel source.[10] It is doubtful that the high PCP waste will be accepted as fuel unless shown to have sufficient BTU value. An additional characterization of the lagoons is planned in order to better define the volume and physical makeup of the material. In addition, this characterization will be used to apply for approval for off-site recycling for energy recovery in the cement kiln.

In the event off-site facilities do not approve the material, the material and debris would be finely ground and incorporated into the bioremediation treatment cell. The material will be tested and blended so that the theoretical maximum treatment concentration of 1000 ppm PCP will not be exceeded. It is difficult, until reclamation of this area is begun to estimate the amount of solid wood debris we may encounter. Based upon conversations with Sentinel Industries personnel, this volume could be as high as 20% of the lagoon's volume If tested to be below the draft "industrial use level" of 30 ppm PCP, the over burden from the lagoons will be stored and/or used for other on-site fill needs. After excavation of the lagoons, the area of the lagoons will be graded to blend with the topography with any remaining overburden and a gentle grade made to the southeast.

For the remainder of the material we propose bioremediation. The bioremediation treatment cell will be developed on the west side of the creek and will consist of an imperious clay liner, augmented with bentonite and encompass approximately 40,000 sq ft. The final depth of the media to be treated will be 12" to 18". The area will be constructed as a rectangle on the west side of the creek in a north south direction as shown on Figure 9, Proposed Bioremediation Site Construction. It has been shown in Missouri at a similar site that the microbes necessary for degradation of PCP are present in the surface contaminated soils of wood treater sites.[11]

5.5 Culvert Material

The 1.25 yd^3 of contaminated soil will be removed by temporarily damming the creek with 2-3' earthen material and using a 3"sump pump and 100' hose to divert water around the excavation. The contaminated material will be manually shoveled into 5-gallon pails and then placed in the biological

[10] APPENCIX SECTION D, Letter from MRF Environmental Services to handle F032 wastes.
[11] Feasibility Investigation for Bioremediation of PCP-Contaminated Soil at the Ameson Timber Company, Crawford County, MO, Brian A. Wrenn, Ph.D.,Environmental Engineering Program,Civil Engineering Department,Washington University, July 29, 1999. APPENDIX SECTION A

treatment cell. Confined space entry permit procedures will be necessary for this removal.

6 BIOREMEDIATION TREATMENT CELL

6.1 Construction of Bioremediation Treatment Cell

The area selected for the bioremediation treatment cell is shown on the site map Figure 9. It is approximately 40,000 sq ft in size, which is adequate to treat 800 cubic yards of contaminated soil per batch. This site is selected for several reasons: It allows handling of the excavation materials from the former treatment plant without having to cross the bridge over the nearby creek. It is relatively level and generally out of the flow of traffic at the site. Since the treatment activity will occur over a period of years, this location will not interfere with other cleanup efforts.

Clay from an off-site deposit will be delivered to the site, blended with approximately 5% Bentonite and compacted to form a liner for the bioremediation treatment facility. The bioremediation treatment cell will have an 18" perimeter berm to prevent water run-off from and water run-on to the treatment pad. The berms are to be constructed of the same clay/bentonite mixture as the liner and will rise 18" above the liner as shown in Figure 11 "Cross Section of Bioremediation Pad".

Roofed structures will be constructed over the liner to control precipitation to the bioremediation treatment cell. Moisture to maintain biological activity will be controlled by irrigating with water from the north groundwater collection sump. If this is not adequate, city water will be used. The roofed structures are "pole-barns" with a plastic greenhouse cover, and are to be constructed in units of 50 feet wide. The adjoining units will be 100 feet by 400 feet long when completed. Gutters are incorporated between the units to divert rain water the on site creek. The structures may also extend the biological activity by holding soil temperatures longer.

A small sump collection area will be constructed of the clay/Bentonite material in the extreme southeast corner of the cell. The sump will function for collection of any excess water from the liner pad. The sump will hold approximately 200 gallons. We do not anticipate collection of water in the sump since the area is covered by a roof and soil moistures are frequently monitored and are manually maintained within the structure. However, in the event of human error or an unusual storm event, the sump will allow management of excess water. Any water collected in the sump would be reused as necessary to maintain moisture levels in the bioremediation treatment cell or diverted to the carbon treatment system whose discharge contaminate levels are regulated.

6.2 Establishment of the Bioremediation Treatment Cell

The contaminated soil will be spread evenly over the treatment cell to a mean depth of approximately 8 inches. Over the first 30 to 60 days, an amount of untreated sawdust from local sawmills and inoculants up to 50% of the volume of the contaminated soil will

be incorporated into the soil using a small loader and a tractor with an industrial tiller and a plow capable of turning soils to a depth of 12 inches to the clay liner. At least four initial turnings of the soil will be made to homogenize the materials and break up clay. In addition to the sawdust and inoculants. To accelerate the treatment process, Oxygen Release Compound (ORC) may be added at a rate of 0.1% by weight, if testing indicates that minimum oxygen levels of 5% are not achieved. Aerobes are capable of degradation of both PCP and petroleum organics. See Appendix Section B for Technical Bulletin Oxygen Release Compound. The soil will be regularly tested for pH, phosphorus, potassium, calcium, and magnesium. The pH will be adjusted with the addition and incorporation of lime and the nutrients will be adjusted with the addition of an appropriate chemical fertilizer.

After the treatment cell is completed and soils homogenized, the soils will be sampled and tested to establish the base line PCP/Dioxin contamination levels. A composite sample will be taken for each 5,000 sq ft section by dividing the section into eight equal grid plots of 25 ft by 25 ft and taking a representative aliquot core sample from the surface to the liner, from each grid plot. The operation of the treatment cell will begin at this time. Since the bacteria are essentially dormant when temperatures fall below 40 degrees, treatment will only occur between March and October.

6.2.1 Bioremediation Treatment Cell Operation

Once established, the contaminated media will be aerated by turning and tilling, and managed and monitored on at least a monthly basis during the treatment period of March through October. Moisture levels must be maintained. Moisture will be supplemented with water from the North sump using a "trash pump" with a spray nozzle. If sump water is inadequate, water will be added from the site public sources. The combination of the clay liner and the gradual slope of the cell should prevent the contaminated media from becoming water logged and becoming anaerobic. The bulking agent, rotted sawdust, and wood chips, will also assist with oxygen transfer and the prevention of anaerobic conditions. Nutrient levels will also be monitored and adjusted as needed.

6.2.2 The bioremediation treatment cell operating conditions to be monitored are as follows, with desired ranges:

MONTHLY
pH 6 to 8.5
Soil moisture 60 to 80% of field capacity

ANNUALLY
Nitrogen 250 to 300 mg N/kg as ammonium and/or nitrate Phosphate 25 to 50 mg P/kg soil as P_2O_5 or as Phosphate

Removal of treated soils achieving cleanup levels from the bioremediation treatment cell and application of remaining soils for treatment will be required. Treated soils will be used to backfill previous excavations and for final grading of the site.

6.3 Clearance Sampling Criteria for Excavation

Excavation activities are proposed for the former treatment plant area, contaminated roadways, and former lagoons. All visible stained soils will be excavated from the areas and distributed in the bioremediation treatment cell. Excavated areas will be sampled by taking random aliquots and compositing as an extended surface sample (0-6 inches). One aliquot will be collected from each 1000 sq ft of surface area exposed by excavation. One sample will be collected from each 5000 sq ft of exposed area. The sample will be homogenized and split into four quarters. One sample will be sent to the laboratory for testing and one sample split will be provided to EPA. The others will be back-up samples and will be introduced into the bioremediation treatment cell.

If the test indicates contamination above the established project cleanup goals, the excavation with placement of material into the bioremediation treatment cell will be continued and the sampling process repeated. This will continue until the appropriate cleanup goal is achieved.

6.4 Sampling and Analytical Procedures

Field sampling will be in a manner consistent with the "Superfund Program Representative Sampling Guidance: Volume I: Soil, December 1995. Laboratory testing for soils will be by Environmetrics, Inc. in St. Louis, Missouri, using Method 8151A for PCP. Laboratory testing for Dioxins will be by Pace Analytical Laboratories. Sampling and testing for biological degradation of soils for final clean up level compliance will include PCP and Dioxin

6.5 Control of Fugitive Dust

Fugitive dust will first be minimized by assessing the adequacy of moisture levels in soils prior to start of construction. If soils are dry, and/or wind speeds raise concerns, earth-disturbing activities will cease until water is applied to the site to reduce fugitive dust. If the water does not reduce particulate levels adequately, the activity will be shut down until the water controls are adequate or the wind velocity is reduced. No fugitive dust sampling is anticipated. If fugitive emissions are visible, excavation will be shut down until engineering controls are implemented or climatic conditions change. There is no "real time" air monitoring devices for PCP or Diesel. Photo ionization detectors are not sensitive to the contaminates nor are colorimetric tubes available for these contaminates. We will have an explosimeter on site when excavating, which will provide LEL and UEL limits primarily for diesel as kerosene.

7 HYDROGEN RELEASE COMPOUND IN-SITU BIOREMEDIATION

7.1 In-SituTreatment Objectives

The objectives are to enhance below grade anaerobic biodegradation rates and minimize the potential for impacted migration of groundwater off site. Agents will be injected or placed in the "smear zone", that area where ground water will hydrolyze the lactate and carry it down gradient and below the groundwater table to biodegrade pentachlorophenol and petroleum-impacted groundwater within the treatment zone footprint and in trenches placed at right angles to groundwater flow direction. The HRC agent degrades in the environment by hydrolysis to lactic acid and glycerol. There are no negative impacts to the stream or groundwater. There is no RQ for reporting under CERCLA.

The goal is to achieve the public drinking water risk-based groundwater treatment objectives at the property boundary and in the surface water creek for Pentachlorophenol (PCP) of one ug/l.

7.2 Evaluation of Pentachlorophenol Aerobic Degradation Products

Site remediation of soil and groundwater at select locations by in-situ methods is proposed using a product called Hydrogen Release Compound (HRC or HRC-X) created by Regenesis. HRC is a proprietary compound of Regenesis specially formulated for slow release to create anaerobic degradation of PCP for several years. The anaerobic degradation pathways are described in Section C of the Appendix[12]. The HRC material provides a food source for anaerobes, which, as a byproduct of digestion, produce mono-atomic hydrogen, which reacts to cleave the chlorine bond to the ring structure. Reference 7 is a project in Granite City, Illinois where the HRC product was successfully used in the treatment of PCP at a wood treater site. The treatment cutoff trenches are to provide a means to introduce the HRC material underneath the paved parking lots in the front of the property and beneath the floor of the Sentinel warehouse and the department store. We believe these covered and paved areas are functioning under anaerobic conditions.

[12] The Use of Hydrogen Release Compound (HRC) to Enhance In-Situ Bioremediation of Chlorinated Aliphatic Hydrocarbons. Regenesis Attachment C of the Appendix.

7.3 *Treatment Zone*

The treatment zone at the site will be from the "smear zone" to bedrock. Figure 7, Proposed Remediation Excavation and Trench Locations, indicates the locations where HRC in-situ bioremediation is proposed. Figure 10, Schematic of HRC Treatment Barrier, is a schematic diagram of the proposed trench configurations.

7.4 *Treatment Trench*

A treatment barrier wall will be installed at three key locations at the southern portion of the site to biodegrade residual pentachlorophenol that may still be present in site groundwater following the source removal effort. The trench will be excavated using a backhoe or similar equipment with a 2-foot wide bucket. Thus, the trenches will be 2-foot wide by approximately 50 to 100-foot long with a depth to bedrock of approximately 7-10 feet below ground surface. If highly weathered bedrock is encountered, we do not plan a deeper penetration. The purpose of the trench is to place nutrients into the ground water for anaerobic bacterial uptake. Down gradient flow can still enter the weathered bedrock.

Based upon the tight clay soils and low groundwater flow rates in the vicinity of the site, trench dewatering should not be a problem. If trench dewatering is required, the water will be collected and transferred to the on-site groundwater treatment system for processing prior to discharge. Due to the tight clay soils, we do not believe trench collapsing will occur. However, if this is a concern during excavation, plywood and 2X4 bracing will be installed. The piping for the installation will be assembled above grade and lowered into position. Although personnel entry into the trenches is not anticipated, shoring devices as well as confined space entry procedures are required before any attempted entry into such an excavation.

The trenches will be backfilled with a mixture of sand/pea gravel/HRC from the higher of the groundwater level or 4 ft bgs depth (This varies seasonally) (assumed to be 4 bgs) to the bottom of trench (refusal on bedrock). The upper four feet of the trench will be backfilled with clean select fill. Four-inch diameter wells screened from 4 feet bgs to bedrock will be installed within the trench. These wells will be keyed into a 4-inch perforated pipe located on the bottom and running the length of the trench. These wells may be used to replenish HRC, as necessary. Figure 10 is a schematic of the proposed treatment barrier.

7.5 *Hot Spot Treatment*

Soil excavation/disposal in select areas is intended to remove the majority of the mass of pentachlorophenol contributing to pentachlorophenol impact to groundwater. Excavations that extend below typical groundwater elevations will also be considered as candidate areas for application of HRC. In these cases, bulk HRC would be applied to the floor of the excavation prior to backfill. Excavations will go to bedrock. As stated in paragraph 5.1.1.1 of the sampling plan the bottom of the trench is not being tested since the trench will extend to bedrock. The HRC would provide a source for the anaerobic degradation of residual levels of pentachlorophenol in the floor and surrounding area of the excavation. This will not affect the use of the ORC material in the bioremediation treatment cell. ORC in the bioremediation treatment cell is a slow release oxygen agent to provide a source of oxygen to the aerobic bacteria.

7.6 *HRC Application Rates*

To estimate the required HRC application rates an average soil pentachlorophenol concentration of 5 mg/kg and an average groundwater pentachlorophenol concentration of 10 mg/l were assumed since the majority of source material will have been removed prior to application of this technology. A soil porosity for fairly tight clays of 37% was used to calculate the pore volume. The following quantities of HRC-X per location are proposed.

- Footprint of excavation (20 ft. by 60 ft. area) – 280 pounds of HRC placed in bottom of excavation in areas that are located in the saturated zone;
- Trench 1 (50 foot long) – 210 pounds of HRC evenly distributed in the bottom of the trench and another 210 pounds placed 2 foot up from the bottom of the trench;
- Trench 2 (100 foot long) – 420 pounds of HRC evenly distributed in the bottom of the trench and another 420 pounds placed 2 foot up from the bottom of the trench; and
- Trench 3 (100 foot long) – 420 pounds of HRC evenly distributed in the bottom of the trench and another 420 pounds placed 2 foot up from the bottom of the trench.

Material removed from the trenches will be tested and moved to the bioremediation treatment facility if it is above 30 ppm PCP. If it tests below 30 ppm PCP, the soils will be stored on site for future use in grading. Clean fill will be used to backfill trenches. The excavation along the culvert will not be backfilled initially and a permanent-type fence will be installed. This area will be evaluated for possible further action while it is exposed. It will be filled prior to project completion.

ORC and HRC materials are not used together. ORC is used for slow release of oxygen to the aerobes in the bioremediation treatment cell. HRC is used for in situ treatment and provides a lactic acid food source to anaerobes which release hydrogen in there digestive process for cleavage of the chlorine atoms on the PCP molecule.

7.7 Monitoring

The following analyte list will serve as the basis for establishing a baseline and for monitoring in new and existing piezometers located down gradient of each treatment area.

Quarterly sampling is proposed for the following parameters at selected locations:

- Pentachlorophenol;
- Total Organic Carbon (TOC);
- Alkalinity;
- Total iron;
- Total manganese
- Chloride,
- In addition, field parameters for redox potential, Temperature, pH, specific conductivity and dissolved oxygen.

8 ENVIRONMENTAL REGULATORY REQUIREMENTS

The MDNR, Water Pollution Control Program indicated that an underground injection permit (UIC) is required for the HRC trenches. A permit application for the use of the HRC in the trenches will be filed upon approval of the plan. Sentinel currently has a NPDES for carbon treatment plant effluent. To our knowledge, there are no other environmental regulatory permits required for the site activities.

9 PROJECT SCHEDULE

REVISED August 25, 2004												
SENTINEL PROPOSED SCHEDULE												
LAFSER & ASSOCIATES, INC.	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
	Mo-1(9-04?)	Mo-2	Mo-3	Mo-4	Mo-5	Mo-6	Mo-7	Mo-8	Mo-9	Mo-10	Mo11	Mo12
COMMENCE IMPLEMENTATION - 2004-5												
PUBLIC MEETING		X										
UCI PERMIT APPLICATION / FEE?		X										
DESIGN/OVERSEE CLAY/BENTONITE LINER	X	X										
BERMS AND SUMP/ELECTRIC SUP (By Client)		X										
DEVELOPMENT OF AND TEST & INOCULATES		X	X									
ERECT/BUILD 100'X200'GREENHOUSE #1		X	X									
SUP. EXC / TEST OLD PLANT & HRC TRENCHES			X	X								
SUP. EXCAVATION CLEARANCE TEST WEST ROAD								X				
SUP. FILL/BLEND CELL W/PLANT/TRENCH SOILS			X	X								
OPERATE BIOREMEDIATION TREATMENT CELL				X			X	X	X	X	X	X
MONTHLY BIO TREATMENT CELL SAMPLING				X				X	X	X	X	X
ERECT/BUILD 100'X200'GREENHOUSE #2						X	X					
INSTALL 2 PIEZOMETERS					X							
INSTALL MONITORING WELLS					X							
SUP. HRC TRENCHES AND DISTRIBUTORS			X	X								
OPERATE / TEST / CARBON SOUTH SUMP							X	X	X	X	X	X
QUARTERLY SURFACE WATER SAMPLING			X			X			X			X
QUARTERLYWELL SAMPLING			X			X			X			X
QUARTERLYHRC MICROWELL SAMPLING			X			X			X			X
PROGRESS REPORTS TO EPA (15TH)	X	X	X	X	X	X	X	X	X	X	X	X
YEAR 2 - 2005-6	Mo-1	Mo-2	Mo-3	Mo-4	Mo-5	Mo-6	Mo-7	Mo-8	Mo-9	Mo-10	Mo-11	Mo-12
	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
OPERATE/TEST/CARBON/ SOUTH SUMP	X	X	X				X	X	X	X	X	X
OPERATE BIO TREATMENT CELL W/ SI	X	X					X	X	X	X	X	X
MONTHLY BIOTREATMENT CELL SAMPLING	X	X							X	X	X	X
SURFACE WATER STREAM SAMPLING/QA/QC			X			X			X			X
QUARTERLY WELL SAMPLING / QA/QC			X			X			X			X
QUARTERLY HRC MICROWELL SAMPLING / QA/QC			X			X			X			X
CHARACTERIZATION OF LAGOON				X								
PROGRESS REPORTS TO EPA (15TH)	X	X	X	X	X	X	X	X	X	X	X	X
YEAR 3 - 2006-7	Mo-1	Mo-2	Mo-3	Mo-4	Mo-5	Mo-6	Mo-7	Mo-8	Mo-9	Mo-10	Mo-11	Mo-12
	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
OPERATE/TEST/CARBON/ SOUTH SUMP	X	X	X				X	X	X	X	X	X
OPERATE BIOREMEDIATION TREATMENT CELL	X	X					X	X	X	X	X	X
MONTHLY BIOTREATMENT CELL SAMPLING	X	X							X	X	X	X
SURFACE WATER STREAM SAMPLING			X			X			X			X
QUARTERLY WELL SAMPLING			X			X			X			X
QUARTERLYHRC MICROWELL SAMPLING			X			X			X			X
REPLENISH HRC TRENCHES	X	X										
SUP. EXC/ REMOVE YEAR 1-2 TREATED SOILS		X	X									
SUP. EXC. /CLEARANCE TEST EAST ROAD SOILS			X									
SUP. FILL/DEV LF W/ EAST ROAD SOILS			X									
SUP. PARTIAL EX LAGOONS FOR DISP/TREATMENT					X	X						
SUP. OFFSITE DISP. / ADD. TREATMENT COSTS?						X						
SUP. FILL BIO CELL WITH WEST LAGOON MAT'L					X	X						
PROGRESS REPORTS TO EPA (15TH)	X	X	X	X	X	X	X	X	X	X	X	X
YEAR 4 - 2007-8	Mo-1	Mo-2	Mo-3	Mo-4	Mo-5	Mo-6	Mo-7	Mo-8	Mo-9	Mo-10	Mo-11	Mo-12
	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
OPERATE/TEST/CARBON/ SOUTH SUMP	X	X	X				X	X	X	X	X	X
OPERATE BIOREMEDIATION TREATMENT CELL	X	X					X	X	X	X	X	X
MONTHLY BIOTREATMENT CELL SAMPLING	X	X							X	X	X	X
SURFACE WATER STREAM SAMPLING			X			X			X			X
QUARTERLY WELL SAMPLING			X			X			X			X
QUARTERLYHRC MICROWELL SAMPLING			X			X			X			X
PROGRESS REPORTS TO EPA (15TH)	X	X	X	X	X	X	X	X	X	X	X	X
YEAR 5 - 2008-9	Mo-1	Mo-2	Mo-3	Mo-4	Mo-5	Mo-6	Mo-7	Mo-8	Mo-9	Mo-10	Mo-11	Mo-12
	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
OPERATE/TEST/CARBON/ SOUTH SUMP	X	X	X				X	X	X	X	X	X
OPERATE BIOREMEDIATION TREATMENT CELL	X	X					X	X	X	X	X	X
MONTHLY BIOTREATMENT CELL SAMPLING		X							X	X	X	X
SURFACE WATER STREAM SAMPLING			X			X			X			X
QUARTERLY WELL SAMPLING			X			X			X			X
QUARTERLYHRC MICROWELL SAMPLING			X			X			X			X
REPLENISH HRC TRENCHES	X	X										
EXCAVATION OF YEAR 3-4 TREATED SOILS				X	X							
EXC/COMPLIANCE TEST CTR LAGOON MATERIAL					X	X						
FILL BIO CELL WITH CENTER LAGOON MAT'L					X	X						
PROGRESS REPORTS TO EPA (15TH)	X	X	X	X	X	X	X	X	X	X	X	X
YEAR 6 - 2009-10	Mo-1	Mo-2	Mo-3	Mo-4	Mo-5	Mo-6	Mo-7	Mo-8	Mo-9	Mo-10	Mo-11	Mo-12
	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
OPERATE/TEST/CARBON/ SOUTH SUMP	X	X	X				X	X	X	X	X	X
OPERATE BIOREMEDIATION TREATMENT CELL	X	X					X	X	X	X	X	X
MONTHLY BIOTREATMENT CELL SAMPLING	X	X							X	X	X	X
SURFACE WATER STREAM SAMPLING			X			X			X			X
QUARTERLY WELL SAMPLING			X			X			X			X
QUARTERLYHRC MICROWELL SAMPLING			X			X			X			X
PROGRESS REPORTS TO EPA (15TH)	X	X	X	X	X	X	X	X	X	X	X	X
YEAR 7 2010-11	Mo-1	Mo-2	Mo-3	Mo-4	Mo-5	Mo-6	Mo-7	Mo-8	Mo-9	Mo-10	Mo-11	Mo-12
	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
OPERATE BIOREMEDIATION TREATMENT CELL	X	X	X									
MONTHLY BIOTREATMENT CELL SAMPLING	X	X	X									
REMOVE/CLOSE WELLS			X									
REMOVE/CLOSE HRC TRENCHES				X								
REMOVE GREENHOUSES								X				
FINAL GRADE /SEED SITE									X			
PROGRESS REPORTS TO EPA (15TH)	X	X	X	X	X	X	X					
FINAL REPORT							X					

10 SAMPLING SCHEDULE TABLE 1

TABLE 1 SAMPLING SCHEDULE 8-25-04				
Sample type/ location/frequency	**Other**	**Dioxin**	**PCP**	**HRC***
GROUNDWATER				
Trench Monitoring				
Quarterly				
PZ-9			1	1
PZ-10			1	1
PZ-11			1	1
PZ-15			1	1
PZ-17 NEW PIEZO			1	1
PZ-18 NEW PIEZO			1	1
QA/QC			1	1
Total per quarter		0	7	7
Total per year		0	28	28
Site well Monitoring				
Quarterly				
ESC-MW-24			1	
ESC-MW-25			1	
ESC-MW-26			1	
MW- 4 NEW WELL			1	
MNDR-MW-3			1	
MNDR-MW-1 Q/C			1	
PZ-1 Q/C			1	
PZ-4			1	
PZ-6			1	
PZ-8			1	
PZ-12			1	
Total per quarter		0	11	0
Total per year		0	44	0
SURFACE WATER				
Quarterly				
SW-3 Q/C			1	
SW-4			1	
SW-5.5			1	
Total per quarter			3	
Total per year		0	12	0
BIOREMEDIATION SOILS				
2-4 wks				
Moisture, pH				
Monthly May-October				
1 Composite of 8 aliquots for each 5,000 sq. ft. section			8	
Total per seasonal year		0	48	0
Annually				
1 Composite of 8 aliquots for each section for Oxygen, Nitrogen, Phosphorus, and Potassium per 5,000 sq. ft.	8			
Total per Year	8			
Clearance Per 2 year Batch Cycle				
1 Composite of 8 aliquots for each 10,000 sq. ft. section		4		
Allowance for Retest			16	
Total per treatment batch cycle		4	16	
TREATMENT CELL WATER				
Quarterly				
Sump if water present			4	
Total per year			16	
ADDITIONAL LAGOON CHARACTERIZATION		4	20	
EXCAVATION CLEARANCE BOUNDARY SOILS				
3 Composites of 6 aliquots for each of five excavations		15	15	
Retest		5	15	
QC Duplicate		3	5	
Total		23	35	
WATER TREATMENT ACTIVATED CARBON				
Monthly				
Influent			1	
Effluent				
Monthly - pH, temp, PCP	1		1	
Annually - Wet Test	1			
Primary Activated Carbon Cell Discharge			1	
Total per year (8 Months)	9		17	
WELL INSTALLATION SOILS				
PZ-17 3 levels one time			3	
PZ-18 3 levels one time			3	
Total first year			6	
CONTINGENCY SAMPLES	10	2	20	4

*note (HRC) Hydrogen Release Compound Analytes
Organic Carbon, Mn, Fe, Cl, TOC, Alkalinity

11 LIST OF FIGURES

Figure Number **Figure Name**

12 APPENDIX

A. Feasibility Investigation for Bioremediation of PCP-Contaminated Soil at the Arneson Timber Company, Crawford County, Missouri
B. Technical Bulletin Oxygen Release Compound
C. The Use of Hydrogen Release Compound (HRC®) to Enhance In-Situ Bioremediation of Chlorinated Aliphatic Hydrocarbons
D. MRF letter to handle F032 wastes
E. THE USE OF HRC® FOR PCP DEGRADATION, Neil Brown (Ecology and Environment inc.), Fred Nika (Illinois EPA, Springfield), Scott Mullin, Kevin Lapus (Regenesis)

A. Feasibility Investigation for Bioremediation of PCP-Contaminated Soil at the Arneson Timber Company, Crawford County, Missouri

Feasibility Investigation for Bioremediation of PCP-Contaminated Soil at the Arneson Timber Company, Crawford County, MO

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Introduction

Site Description:

The Arneson Timber Company site is an approximately 1 acre site located near the top of a ridge in an unincorporated, wooded area in Crawford County, MO. This site was used for timber cutting and wood-preserving operations between 1978 and January 1983. Pentachlorophenol (PCP) dissolved in diesel fuel was the only wood-preserving chemical used at this site.

The surface soil is a stony loam 8 to 15 inches deep underlain by a well-developed red clay. The presence of a large number of stones and a high percentage of clay are important factors for bioremediation feasibility at this site. PCP concentrations ranging from below the detection limit to 1,400 mg/kg soil were observed during site investigations. (The median PCP concentration for all samples that were analyzed is 1.1 mg/kg, and 75% of all analyzed samples contained less than 10 mg PCP/kg soil.) Most contaminated soil samples were collected from within 12 inches of the ground surface, but deeper contamination is suspected in the vicinity of a filled former sludge containment basin and the former drip pad.

Technical grade PCP is about 85-90% PCP, with the remainder consisting of lower chlorinated phenols (esp. tri- and tetrachlorophenols). Polychlorinated dibenzodioxins and dibenzofurans (PCDD/Fs) are also frequent contaminants of technical-grade PCP formulations. The most abundant_ dioxin in technical-grade PCP is octachloro p-dibenzodioxin (OCDD), which is relatively nontoxic (Crosby, 1981). Dioxins have been observed at the Arneson Timber site at concentrations up to 10 µg/kg as 2,3,7,8-TCDD equivalents, which is equal to the EPA's action level for PCDD/Fs in industrial-use soils at depths of 0 to 48 inches. Tri- and tetrachlorophenols are biodegradable, but dioxins are not.

Proposed Treatment:

The proposed remedial action for PCP-contaminated soil at this site is landfarming, which relies on aerobic biodegradation of the target contaminants. Contaminated soil will be excavated and placed in a treatment cell that will be surrounded by soil berms to control run-on and runoff. The soil in the treatment cell will be monitored and managed to optimize biodegradation of PCP and its fuel-oil carrier.

PCP and diesel fuel are both known to be biodegradable by a wide variety of common aerobic microorganisms (McAllister *et al.,* 1996; Song *et al.,* 1990). In many cases, the organisms that catalyze biodegradation reactions use the contaminants as growth substrates (Saber and Crawford, 1985; Song *et al.,* 1990). Some microorganisms can transform PCP and diesel-fuel hydrocarbons during growth on other organic substrates (Banerji and Bajpai, 1994; Sato and Lee, 1996; Lamar *et al.,* 1990). This type of "cometabolic" process is the basis for a well-studied technology for treating PCP-contaminated soil: inoculation with white-rot fungi (Lamar *et al.,* 1990; Lamar and Dietrich, 1990; EPA, *1995).* Unfortunately, white-rot fungi mineralize (i.e.., convert to harmless inorganic products like CO, and H2O) only a small percentage of the PCP that is removed (Lamar *et al.,* 1990). The remainder is converted to volatile products, such as pentachloroanisole. or incorporated into soil organic matter. Incorporation of PCP into soil humus is not accompanied by a significant amount of dechlorination, and the

ultimate fate and environmental effects of the chlorinated aromatic residues in soil organic matter are unknown. Therefore, processes result in contamination mineralization, such as occurs when indigenous soil bacteria grow on PCP, are preferable.

Factors Affecting the Biodegradation of PCP:

As with any aerobic biological process in which the target contaminant supports microbial growth, the success of PCP bioremediation at the Arneson Timber site will depend on:

1) the presence of a competent microbial population (i.e., PCP degraders);

2) an adequate rate of oxygen transfer to the soil;

3) the presence of sufficient available nutrients;

4) neutral pH (between about 6 and 8.5); and

5) soil moisture content maintained within the optimal range (60 to 80% of the field capacity)

In addition to the factors listed above, PCP bioremediation frequently benefits from addition of wood chips, sawdust, or compost. These materials serve several functions, including provision of additional carbon sources to support growth of a diverse microbial population (which often results in more complete biodegradation), adsorption of PCP (which reduces the toxicity to soil microbes), and as a bulking agent to improve the water-holding and oxygen-transfer characteristics of the soil.

A study was conducted to determine whether PCP degraders are present in contaminated soil at the Arneson Timber site. Data collected during this study conclusively demonstrated that microorganisms with the ability to grow on and degrade PCP exist at this site (see Appendix). Also,, the, size of the total heterotrophic.microbial population is within the range expected for surface, soils, I(Alexander,1977; Konopka and Turco, 1991), which indicates that unrecognized toxicity is probably not a problem.

In landfarming, aeration is provided by frequent tilling. The soil moisture content can be managed by irrigation and provision of an underdrain or leachate collection system. The nutrient concentration and pH of the contaminated soil can be adjusted by addition of appropriate amendments (e.g., commercial or organic fertilizer for nutrients, lime, crushed limestone, or sulfur for pH control).

<u>Recommendations for Bioremediation of PCP-Contaminated Soil at the Arneson Timber Site</u>

(1) The soil at the Arneson Timber site is a mixture of clay, gravel, and a loamy

sand. The clay and gravel, in particular, will make it difficult to mix the soil and amendments during bed preparation. The clay will reduce the rate of oxygen transfer into the soil and will make moisture management difficult. Therefore, addition of wood chips or sawdust as a bulking agent will be very beneficial at this site.

a) The quantity of bulking agent added to PCP-contaminated soils varies from zero to >I 00% of the volume of soil treated (Laine and Jorgensen, 1997; Laine *et al.,* 1997; Trudell *et al.,* 1994; Johnston *et al., 1997;* McGinnis *et al.,* 1991). The poor quality of this soil suggests that a relatively large proportion of sawdust or wood chips should be used. A volume of sawdust or wood chips equal to 50-100% of the volume of soil that will be treated should be mixed with the contaminated soil during construction of the landfarm treatment cell.
   - Since a relatively large volume of bulking agent is recommended and the high clay and gravel content of the contaminated soil will reduce the efficiency of sawdust or wood chips should be added gradually over the first 2-3 months of operation. The amendments can be mixed into the soil bed during regularly scheduled tilling operations.

b) Since this soil, especially areas dominated by clay, appears to contain relatively small amounts of natural organic matter, addition of compost or composted manure, may also be beneficial. If compost is added, reduce the volume of sawdust so the total amount of amendment does not exceed 100% of the volume of the contaminated soil.
   - Although composted yard waste and composted manure will both provide beneficial organic matter, composted manure will also function as a slow-release source of nutrients (see Recommendation 3). Composted chicken manure and livestock bedding material are particularly useful as nutrient amendments.

(2) The pH and moisture content of soil samples collected for microbial enumeration are given in Table 1. The averages reported are based on analysis of five independent replicate samples from each location.

Table 1: Characteristics of soil samples collected from the Ameson Timber site

Location	soil type	contamination status	average pH	soil moisture (%)*
drip pad	'gravel and loam	stained; oily	6.47±0.20	13.5±3.6
catch basin	clay and gravel	stained, oily	5.60±0.52	16.8±4.3
background	silty loam	clean	6.75±0.44	10.6±1.4

*soil moisture = mass water per mass dry soil x 100%

a) Although the pH of the soil collected near the former drip pad is within an acceptable range, the soil collected from the former catch basin area is too acidic. If a sufficient quantity of the soil in the landfarm treatment cell

is from the catch basin or an area with similar soil characteristics, pH adjustment will be necessary. The pH should be maintained between about 6.5 and 8. The pH can be adjusted by adding crushed limestone or lime, but the exact quantity required must be determined empirically.

- The landfarm treatment cell, with all other amendments added, should be constructed before the need for pH adjustment is determined. If pH adjustment is necessary, the amount of crushed limestone that is needed can be estimated and the appropriate amount can be added during one of the regularly scheduled tilling operations.

b) The soil moisture content listed above is for the native soil. Assuming the porosity is about 30% and the solids density is 2.65 g/cm3, these values represent 65% (clean background) to 104% (catch basin) saturation. The optimum soil moisture content for bioremediation is between 60 and 80% of saturation.

- If the soil becomes water logged following a heavy rain, anaerobic conditions could develop. Although temporary anaerobiosis will not affect the long-term prospects d r biological treatment of these soils, aerobic biodegradation will not occur as long as oxygen is absent. Therefore. a drainage system should be provided it maximum remediation rates are desired.

c) The soil pH and moisture content of the landfarm treatment cell can be monitored in the field using a Kelway Soil Acidity and Moisture Tester (Model HB-2). The field instrument should be calibrated periodically according to the manufacturer's recommendations.

(3) The nutrient content of the soil should be adjusted by addition of commercial fertilizer (e.g.., ammonium nitrate plus soluble phosphate). Sufficient fertilizer should be added to raise the nitrogen concentration to about 250 to 300 mg N/kg soil as ammonium and/or nitrate and the phosphate concentration to about 25 to 50 mg P/kg soil as P205 or as phosphate (Lain and Jorgensen, 1997; Laine *et al.*, 1997; Trudell *et al.*, 1994).

- Alternatively, composted manure or livestock bedding material can be added to supply nutrients (see Recommendation 1). If manure or bedding material is used, the readily available nutrient fraction (i.e.., ammonia, urea, and soluble phosphorus) should be determined in addition to total N and P.

(4) The contaminated soil in the landfarm should be tilled frequently enough to maintain a soil-gas O_2 concentration of at least 5% (Sims, 1996). To insure that this aeration requirement is met, the soil should be treated in maximum lifts of 12 to 15 inches, and it should be tilled frequently. Tilling every other week for the first few months followed by monthly tilling thereafter should provide adequate aeration.

- Since biological activity will be minimal during the winter, tilling should not be

conducted: during cold weather. .Tilling should be stopped, when the average daytime temperature falls below 40° F and should not begin again until it rises above 40° F in the spring. In general, this will probably be between about October 15 and April 15.

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Appendix: Microbial Enumeration in Soil Samples from the Arneson Timber Site

Sample Locations and Collection Procedures:

Soil samples were collected from the Arneson Timber Site and an adjacent uncontaminated area on June 2, 1999. Sample locations were chosen based on the known distribution of PCP contaminated soil at the site. One set of samples was collected from a largely unvegetated area immediately north of the former drip pad, and another set was collected from a similarly unvegetated area in the vicinity of the former catch basin. The background samples were collected from a heavily vegetated area about 100 ft south of the property line on the same ridge as the former wood-treatment facility. Five samples were collected from each site. In both sets of samples collected from areas with known contamination, one sample was collected from a position that was within the unvegetated perimeter but which had substantial plant growth. In both of these cases, the vegetated soil appeared to be free of oily contamination, whereas the samples collected from the unvegetated areas were dark stained and had an oily odor and texture.

Samples were collected from within 6 to 12 inches of the ground surface by digging a small hole, then using sterile stainless steel spoons to remove soil samples from its wall. Aseptic technique was used to collect the samples: the spoons were soaked in 70% ethanol in between uses and flamed using a propane torch immediately before each use. Two spoons were used for each sample. ; One sterile spoon was used to remove soil from the wall that may have come into contact with the shovel used to dig the hole, and the second sterile spoon was used to collect samples from, the freshly exposed sections of the walls. These precautions ensured that soil and/or bacteria were not transferred between sample locations by any of the sampling equipment.

Methods for Bacterial Enumeration.

Four groups of bacteria were enumerated in the soil samples: (1) heterotrophic bacteria,

(2) PCP-tolerant heterotrophic bacteria,

(3) PCP-cometabolizing bacteria, and

(4) bacteria capable of using PCP as the sole growth substrate.

Heterotrophic bacteria, PCP-tolerant heterotrophs, and PCP cometabolizers were enumerated by plate counts on solid media. A dilute, nutritionally complex medium (1:20 strength PYG, peptone-yeast extract-glucose, medium) was solidified with agar (1.5%) for the plate counts. PCP-tolerant bacteria were enumerated on agar plates containing 1:20 PYG plus PCP (200 mg/L). PCP cometabolizers were enumerated on the PYG + PCP plates by counting colonies that were surrounded by a clearing zone, which indicates that PCP biodegradation had occurred. (The PCP precipitated in the agar forming a hazy suspension of solid PCP. Metabolism of PCP in the vicinity of active colonies reduced the concentration to below its solubility limit, resulting in the appearance of a clear "halo" around the colonies.) Bacteria able o grow on PCP were enumerated using a most-probable-number (MPN) procedure

with an
aqueous mineral salts medium containing PCP (100 mg/L) as the sole source of carbon and energy.

Soil samples were prepared for these enumeration procedures by shaking 10 g soil in 100 mL of a 0.1 % tetrasodium pyrophosphate solution (pH = 7.1) for 1 hour at 400 rpm on a gyratory shaker to release the bacteria from the soil surfaces. The supernatant liquids from each sample were diluted by a serial 10-fold dilution procedure using 0.1 % tetrasodium pyrophosphate as the dilution medium. For plate counts, 0.1 mL of selected dilutions were transferred to the surface of an agar plate, and the liquid was spread over the surface using a bent glass rod, which were soaked in 70% ethanol between uses and flamed immediately before each use to sterilize the surface. Colonies were counted after incubation in the dark for 1 week at room temperature. For the MPN procedures, 1.0 mL of selected dilutions (from 10^0 to 10^{-6} times the initial concentration) were added to 9.0 mL of sterile PCP-containing mineral salts medium. The MPN tubes were incubated in the dark at room temperature for 5 weeks prior to scoring them for growth. Wells were considered to be positive for growth if the PCP concentration (measured by absorbance at 320 run) was reduced by about 20% ($P < 0.05$ for comparison of A_{320} in inoculated tubes to the average $_{A320}$ of 10 uninoculated tubes).

Results:

The plate count data are reported in Table 2 and shown in Figure 1. Total heterotrophic .bacteria are relatively abundant at all three sample locations, indicating that generally inhibitory conditions do not exist at this site. The number of heterotrophic bacteria present in the catch basin samples is significantly lower ($P < 0.05$) than at the other two sites, but the size of the microbial population is still within the range .expected for surface soils. The smaller size of the microbial population in. the catch, basin samples might be due to the low pH of this soil or its very high clay and low natural organic matter content (Fredrickson *et al.*, 1989; Konopka and Turco, 1991). At all three locations, PCP-tolerant heterotrophic bacteria: and PCP cometabolizing bacteria constitute a very small fraction of the total microbial population. Both groups of bacteria represent similar proportions of the total microbial populations (2% and 1 for PCP-tolerant and PCP-cometabolizing bacteria,. respectively) at the two PCP-contaminated locations, but they are a much smaller fraction of the microbial population (0.3% and <0.2%, respectively) at the clean background location. PCP cometabolizers were not observed in samples from the background location. The approximately order-of-magnitude lower abundance of PCP-tolerant and PCP-cometabolizing microorganisms in the background samples is expected, because there is no selective pressure that would give such organisms a competitive advantage in the clean soil.

Table 2: Plate count data from Arneson Timber site soil samples

log(CFU/g soil)

Sample Location	total heterotrophs	PCP- heterotrophs	PCP cometabolizers
Background	6.61 ±0.18	4.03± 0.74	ND*
Drip Pad	6.78± 0.43	5.13 ± 1.51	4.79 ± 1.04
Catch Basin	0.02± 0.49	4.32± 0.93	3.77 ± 0.15

*ND not detected; the detection limit for these assays was 10^4 CFU/g soil

Bacteria able to grow on PCP as the sole source of carbon and energy were enumerated by MPN. The results are presented in Table 3. Nine of ten samples collected from contaminated locations at the Arneson Timber site were positive for bacteria capable of growing on PCP, but none of the five samples collected from the uncontaminated background location contained detectable numbers of bacteria with this ability. These data are consistent with the plate count data. The relative numbers of PCP degraders at the Drip Pad and Catch Basin locations are also consistent with the plate count data: higher numbers of bacteria capable of using PCP as the sole growth-supporting substrate were observed in samples collected near the former drip pad than from the former catch basin.

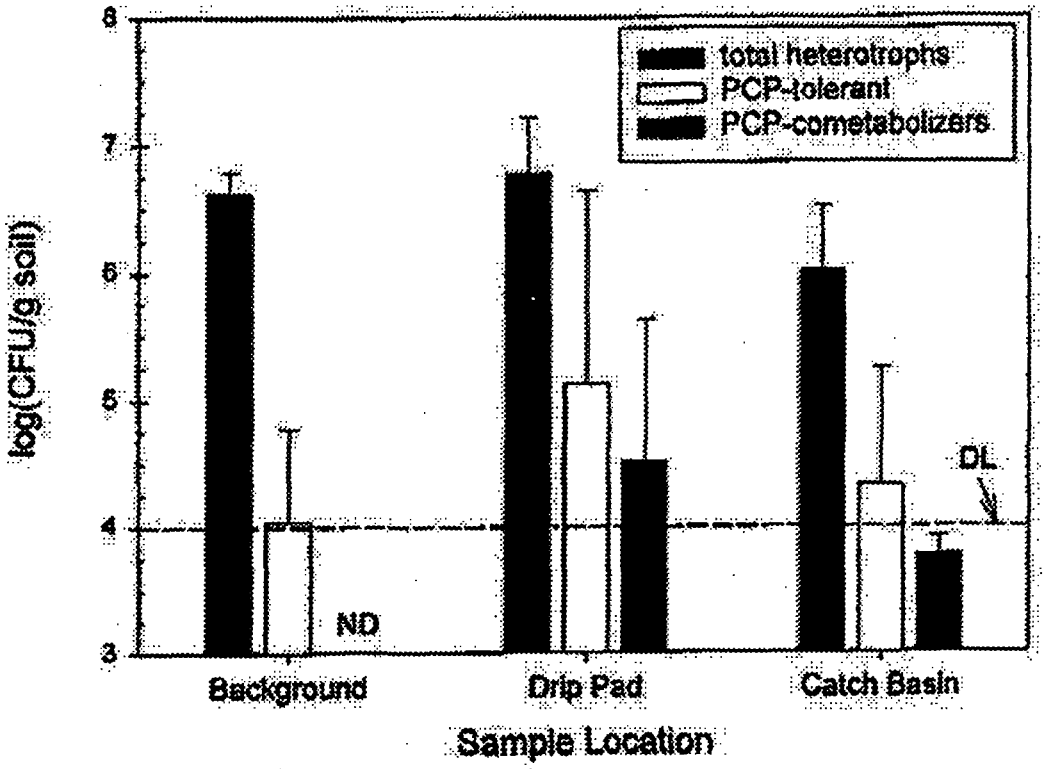


Figure 1: Microbial abundance at the Arneson Timber site. Total heterotrophs represent an estimate of the total size of the microbial population at this site, whereas the PCP-tolerant and PCP-cometabolizing bacteria provide estimates of the proportion of the population that has adapted to the presence of PCP in the soil. PCP cometabolizers were not detected (ND) in soil samples from the clean background site. The detection limit (DL) of these procedures was 10^4 CFU/g soil. PCP degraders were detected in only one of five samples collected in the vicinity of the former catch basin, but they were detected in three of five samples collected near the former drip pad.

Note that the numbers reported in Table 3 are probably conservative estimates, because in addition to being required to use PCP as the sole source of carbon and energy, the bacteria enumerated in the MPN procedure were also forced to make all their own vitamins and other growth factors. Microbial communities frequently involve cross-feeding interactions in which one organism will supply one or more cofactors required for the growth of other organisms. The dilution-to-extinction method upon which the MPN procedure is based precludes these types of interactions, and no alternative source of vitamins (e.g., yeast extract) was provided in this experimental design.

Table 3 Enumeration of bacteria with the ability to use PCP as the sole growth-supporting substrate by a most-probable-number (MPN) procedure

Sample Location	log MPN + SD (PCP degraders/g soil)
Background	ND*
Drip Pad	2.16 ± 1.05
Catch Basin	2.80 ± 1.17

*ND = not detected; the detection limit for this procedure was 10 organisms/g soil

Conclusions

A healthy heterotrophic microbial population is present in contaminated soil at the Arneson Timber site. The density of heterotrophic bacteria (10^6 to 10^7 CFU/g soil) is within the normal range for surface soils (Alexander, 1977; Konopka and Turco, 1991), and the population present in contaminated soil from the vicinity of the former drip pad is comparable to the population present in uncontaminated soil from outside the site boundary. This suggests that unrecognized toxicity that could interfere with bioremediation does not exist at this site. The lightly lower heterotrophic microbial population present in the soil from the former catch basin probably reflects the soil composition (a dense, low-pH clay) rather than the effects of pollution from wood-treating wastes (Fredrickson *et al.,* 1989; Konopka and Turco, 1991).

Although PCP-degrading bacteria constitute a small fraction of the total heterotrophic microbial population in contaminated soils at the Arneson Timber site, their presence suggests that bioremediation can be an effective remedy at this site. The presence of bacteria that are able to use PCP as the sole source of carbon and energy in nine of ten samples collected from contaminated locations provides conclusive evidence that the appropriate metabolic potential exists at this site. The population of bacteria that can metabolize PCP while growing on other substrates is approximately 2 orders of magnitude larger than the population that can grow on PCP as the sole substrate. Amendment of the contaminated soil with degradable organic matter is likely to result in an increase in the size of this population. The absence of organisms adapted to growth on, or in the presence of PCP, in samples collected from the uncontaminated background location strongly suggests that the microbial population within the site boundaries has adapted to the presence of contaminants in the soil.

Although this study did not attempt to determine which factors limit the growth of PCP degraders at the Arneson Timber site, the proposed treatment. which is based on an extensive survey of PCP-bioremediation literature, should stimulate the growth of these organisms and increase their relative abundance in the microbial population. The PCP biodegradation rate increase directly in proportion to the increase in the size of the PCP degrading population. The ultimate result of this process will be bioremediation of the contaminated soil.

B. Technical Bulletin Oxygen Release Compound (ORC®)

OXYGEN RELEASE COMPOUND (ORC®)

ORC is a patented formulation of phosphate-intercalated magnesium peroxide that time releases oxygen when hydrated in accordance with the following reaction:

$$MgO_2 + H_2O \longrightarrow \tfrac{1}{2}O_2 + Mg(OH)_2$$

How it Works

Oxygen is often the limiting factor for aerobic microbes capable of biologically degrading contaminants such as petroleum hydrocarbons. Without adequate oxygen, contaminant degradation will either cease or may proceed by much slower anaerobic (oxygen-free) processes. ORC is designed to release oxygen, into the subsurface, for up to one year depending on site conditions. In the presence of this long-lasting oxygen source, aerobic microbes flourish accelerating natural attenuation of gasoline and fuel additives (BTEX and MTBE), diesel, kerosene, jet fuel, gas condensates, fuel oils, lubricants, bunker oil, PAHs, certain metals (arsenic), certain pesticides/herbicides and certain industrial solvents (alcohols and ketones).

Critical Timed Release

ORC is intercalated with food-grade phosphate, this gives it the time-release properties that are critical in a passive, low-cost oxygen application system. The term "intercalation" is used here to describe the permeation of phosphates into the crystalline structure of magnesium peroxide (Figure 1.). This feature slows the reaction that yields oxygen thus facilitating the extended release. Phosphate intercalation also prevents a process known as "oxygen lock-up." When water reacts with an un-intercalated magnesium peroxide, a cement-like coating of magnesium hydroxide forms which prevents water from penetrating deeper into the crystal to release all of the available oxygen. ORC's phosphate intercalation keeps the crystal "open," preventing this problem and continuing the release of oxygen.

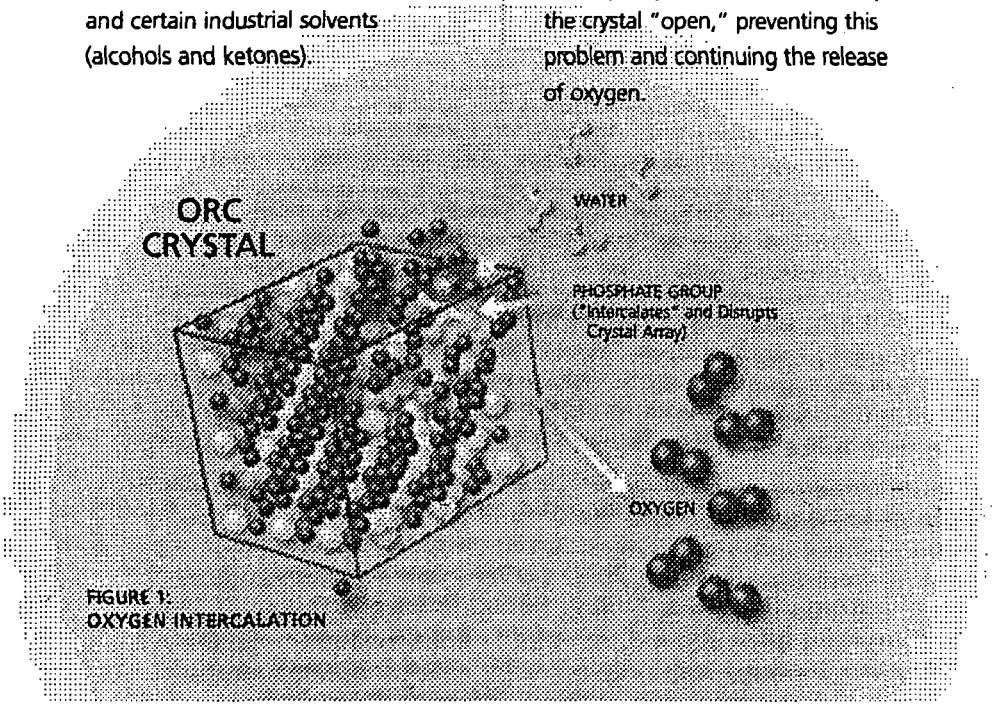


FIGURE 1:
OXYGEN INTERCALATION

Product Applications

ORC is typically applied in the subsurface via direct push injection, borehole backfill or filter socks. When using direct push and/or borehole backfill, ORC powder is mixed with water to form an injectable slurry. The slurry is then pumped into the groundwater where it disperses into the aquifer via diffusive and advective forces.

In filter sock form, ORC is placed into monitoring wells where the compound reacts when contacted with water. Upon exhaustion, which can take up to 1 year, filter socks can be removed and replaced to replenish the oxygen supply and continue treatment. Special canisters are available with filter socks to avoid lodging them in deeper wells (> 40 ft.).

Additionally ORC can be applied into excavated areas either in its native powder form or by broadcasting the slurry mixture. Excavation treatments take advantage of fluctuating groundwater levels and percolation from the surface to activate the oxygen releasing capabilities of ORC.

C. The Use of Hydrogen Release Compound (HRC®) to Enhance In-Situ Bioremediation of Chlorinated Aliphatic Hydrocarbons

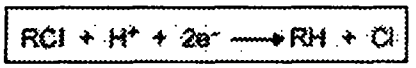
The Use of Hydrogen Release Compound (HRC®) to Enhance In-Situ Bioremediation of Chlorinated Aliphatic Hydrocarbons

Source: Regenesis

The use of HRC® to enhance in-situ bioremediation or natural attenuation of chlorinated aliphatic hydrocarbons (CAHs) has been well documented over the past several years, having been utilized at over 500 sites. It has been widely used at current and former dry cleaning facilities with relative success. The following discussion will focus on the reductive dechlorination process that is facilitated by the injection of HRC® into the environment. The following sections provide background information on the reductive dechlorination process, and the microbially mediated events that occur after the addition of HRC to the saturated zone.

Anaerobic or reductive dechlorination is the most prominent mechanism by which chlorinated aliphatic hydrocarbons (CAHs) are biologically degraded under anaerobic conditions. CAHs commonly used as dry cleaning and degreasing solvents such as PCE, TCE, TCA, and carbon tetrachloride. These are hydrocarbons whose hydrogen atoms have been replaced, or substituted, with chlorine atoms. It is in this chlorinated state that these hydrocarbons are considered toxic in groundwater. In order to remedy this problem the chlorine atoms must be removed from the hydrocarbons.

Reductive dechlorination is the naturally occurring process by which anaerobic microorganisms substitute hydrogen (H+) for chlorine (Cl-) on CAHs. Hydrogen acts as a source of electrons that provide the reducing conditions necessary for dechlorination of CAHs, as shown by the following reaction.



Through this process, chlorinated hydrocarbons can be degraded to the end product ethene, as depicted in Figure 1A.

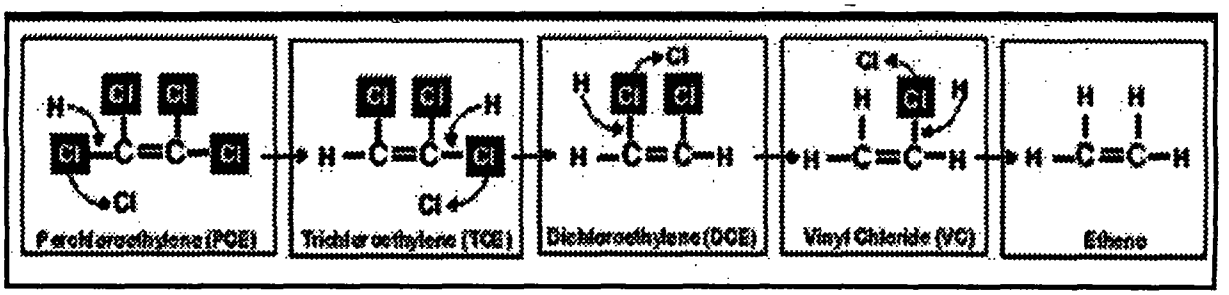


Figure 1A

Anaerobic dechlorination, the process by which Hydrogen Release Compound (HRC®) operates, is a naturally occurring process that operates at very low rates in the absence of organic carbon sources. HRC® is a proprietary product manufactured by Regenesis Bioremediation Products. Applying simple carbon sources such as sugar, molasses, lactic acid, sewage, etc. to the contaminated subsurface environment also have the potential to speed up this process.

The effect of the addition of organic acids and alcohols on the reductive dechlorination of tetrachloroethylene (PCE) is described by Gibson and Sewell (1). However, the addition of these simple carbon sources to the subsurface at the weekly or monthly frequency required to maximize CAH degradation proved to be a costly, time consuming, and a disruptive process to on-going site operations. HRC, once injected into the subsurface, slowly releases lactic acid from 12 to 18 months with longer latent effects. The resulting lactic acid acts as a nutrient source for anaerobic bacteria that metabolize the lactic acid as illustrated in Figure 2A.

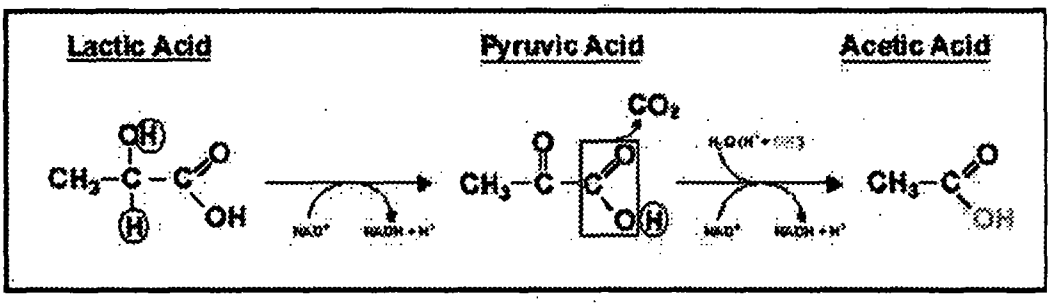


Figure 2A.

Typically, in the conversion of lactic acid to acetic acid, one mole of lactic acid produces two moles of hydrogen as H^+. The hydrogen is then available for conversion of CAHs to dechlorinated aliphatic hydrocarbons.

A series of microbially mediated events set forth from the addition of HRC to an aquifer are as follows:

1. First, the aquifer has to be driven anaerobic if it is not already in that condition. Obviously, this has to be achieved to support the growth and development of anaerobic microorganisms. To achieve this state, all the oxygen and the other electron acceptors such as nitrate, ferric iron, and sulfate have to be consumed. HRC is a source of the lactic acid that is metabolism by anaerobic microorganisms to carbon dioxide and water to reduce the electron acceptors.

2. Now the stage is set for the important reactions that remove chlorinated hydrocarbons. Recognize that the redox potential goes from positive to negative as electron acceptors are consumed. As soon as electron acceptors are reduced, the dynamics of the microbial web shift - as redox potential shifts so do the dominant species of microorganisms in the aquifer. As low to moderate negative redox conditions form, certain kinds of fermentative microorganisms can thrive that will attack the HRC derived lactic acid. It is through this process that the hydrogen is formed.

3. The hydrogen formed by fermentative microorganisms is now available for reductive dechlorination - however, there are other competing microbial processes that also demand hydrogen. The most common of these is methanogenesis. As the name implies this is a methane generating reaction that involves the combination of CO2 with hydrogen.

Recently, some of the experts in the field of reductive dechlorination, including laboratory groups at Cornell and Stanford as represented in the references given, have offered the hypothesis that there is competition for hydrogen between reductive dehalogenators and methanogens. They believe that a low concentration of hydrogen favors the reductive dehalogenators and starves out the methanogens that have a larger appetite for hydrogen.

With an excess of hydrogen in the system the methanogens are favored and crowd out the reductive dehalogenators (Fennel, et. Al, 1997; McCarty and Yang, 1998). Think of landfills that are producing methane yet still leaching out PCE and TCE. Common carbon sources such as molasses or sugar release hydrogen at an uncontrolled rate, thus allowing the hydrogen to build up in concentration. The objective would then be to keep hydrogen concentrations low. This can be accomplished with the use of slow release organic acid materials such as HRC.

When designing an HRC remediation system one must consider all competing uses for the hydrogen generated. By providing a long-lasting, time-released hydrogen source, HRC provides a basis for designing a low-cost, no maintenance in-situ groundwater remediation system for chlorinated solvent contamination at a fraction of the cost of other treatment technologies.

References:

1. Gibson, S.A. and G.W. Sewell. April 1992. Applied and Environmental Microbiology. 58(4): 1392-1393.

2. Fennel, D.E., J.M Gossett and S.H. Zinder. 1997. Environmental Science & Technology. 31: 918-926.

3. Yang, Y. and L. McCarty. 1998. The First International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Platform Presentation. Monterey, California, May 19, 1998.

D. MRF Environmental Services Letter for F032 Waste

Continental Cement Co., LLC

10107 Highway 79
Hannibal, MO 63401
Phone 573-221.1740
Fax 571.221-1689

MFR Environmental Services
10107 Highway 79
Hannibal, MO 63401
Phone 573-248-0730
Fax 573.221-8487

October 6, 2003

Fred Lafser
President
Lafser and Associates
Fax: (314) 878-4442

Dear Mr. Lafser,

Per your recent inquiry, MFR Environmental Services/Continental Cement Company, LLC, is permitted to accept F032 waste as a substitute fuel source. MFR is a fully permitted Part B TSD facility located in Hannibal, MO that accepts and prepares waste material for the purpose of fossil fuel replacement within Continental's "BIF'" permitted cement kiln (located at the same address).

Should you have any questions or require further information please feel free to call me @ (573) 248-0730 (office) or (314) 378-4635 (cell). Thank you for your interest in our company's capabilities and we look forward to working with you in the future.

Respectfully,

M. Lynn Shreve
Sales and Marketing Manager
MFR Environmental Services/Continental Cement Company, LLC

Cc: Diana Hays

MLS

E. THE USE OF HRC® FOR PCP DEGRADATION, Neil Brown (Ecology and Environment inc.), Fred Nika (Illinois EPA, Springfield), Scott Mullin, Kevin Lapus (Regenesis)

THE USE OF HRC® FOR PCP DEGRADATION

Neil J. Brown, P.E. (Ecology and Environment Inc., Chicago, IL)
Fred Nika, P.E. (Illinois EPA, Springfield, IL)
Scott Mullin, Kevin Lapus (Regenesis, San Clemente, CA)

ABSTRACT: The groundwater aquifer at an abandoned wood-treating facility in Granite City, IL was contaminated with pentachlorophenol (PCP) at levels reaching 104 milligrams per liter (mg/L). PCP processes were used at the site from 1960 until 1986. In 1988, a site assessment indicating that soil beneath the site consisted of seams of clayey and sandy soils in the upper 25 feet. Sandy and gravelly soils were encountered below 25 feet, and extended to bedrock. Groundwater was encountered at a depth of approximately 17 feet below ground surface, and was found to flow in a south-southwesterly direction across the site at a velocity of approximately 0.1 feet per day (ft/day). In June 2001, Hydrogen Release Compound (HRC®) was applied via a 7-point injection barrier upgradient of existing monitoring well MW-8S. A total of 1,050 pounds HRC® was used for the pilot study. After nine months, PCP concentrations in MW-8S decreased 98%, from 104 mg/L to 1.91 mg/L, while upgradient PCP concentrations remained elevated. Monitoring results for MW-8S also showed an increase in metabolic acid concentrations (>50 mg/L) and total organic carbon levels (>100 mg/L) over background conditions, indicating that HRC® is stimulating microbial activity in the desired area.

INTRODUCTION

The Jennison-Wright (JW) Superfund site, a 20-acre abandoned wood-treating facility, is located at 900 West 22nd Street in Granite City, Illinois, approximately 6 miles northeast of downtown St. Louis, Missouri. The site is approximately 2 miles east of the Mississippi River, in Section 13, Township 3 North, Range 10 West, in Granite City, Madison County, Illinois.

The JW site is located in an area often referred to as the American Bottoms. In the St. Louis metropolitan area, the Mississippi River occupies a deep bedrock valley that has been filled with both glacial outwash material and recent alluvium. The thickness of the valley fill is generally greater than 100 feet. In the Granite City area, the thickness is about 115 feet. The stratigraphy of the valley fill consists of silt, clay, sand, and gravel (Cahokia Alluvium). The upper 15 to 30 feet is commonly silt and clay with fine sand. Below this depth, the deposits vary from poorly graded to well-graded sand and gravel, grading to coarser sand and gravel that extends to bedrock.

Major supplies of groundwater have historically been withdrawn from the valley fill material. Groundwater in the valley fill deposits occurs under water table (unconfined) conditions. The water table is generally found at depths ranging from 15 to 20 feet below ground surface (BGS). Groundwater flow is primarily south-southwest towards the Mississippi River except in areas of high pumpage, which form large depressions in the water table. The bedrock in this area is considered a poor source of water primarily due to its low permeability and poor water quality (Bergstrom and Walker 1956).

At the JW site, two distinct preserving processes were utilized-creosote and PCP. The creosote process was the first wood-preserving process used at the site, and was employed in operation between the early 1900s and 1989. The PCP process was used at the site from 1960 until 1986.

The PCP process was used to treat decorative wood blocks for flooring. The process solution was made up of a light petroleum distillate base and 5% PCP. Process equipment included a 17,000-gallon treatment cylinder, a 15,000-gallon working tank, a storage tank, a compressor, and a vacuum pump. At the conclusion of the treatment process, the cylinder door was opened and trams holding the treated wood were pulled out of the cylinder. The residual PCP solution at the bottom of the cylinder was then allowed to spill out onto the ground (E & E 1985; WCC 1988). Figure 1 provides a general site features map.

The PCP treatment cylinder and storage tanks were located on the south side of the site, approximately 30 feet from the west boundary of the plant. PCP solution was used at an average rate of 15,000 gallons per year, although this quantity fluctuated depending on demand (E & E 1985).

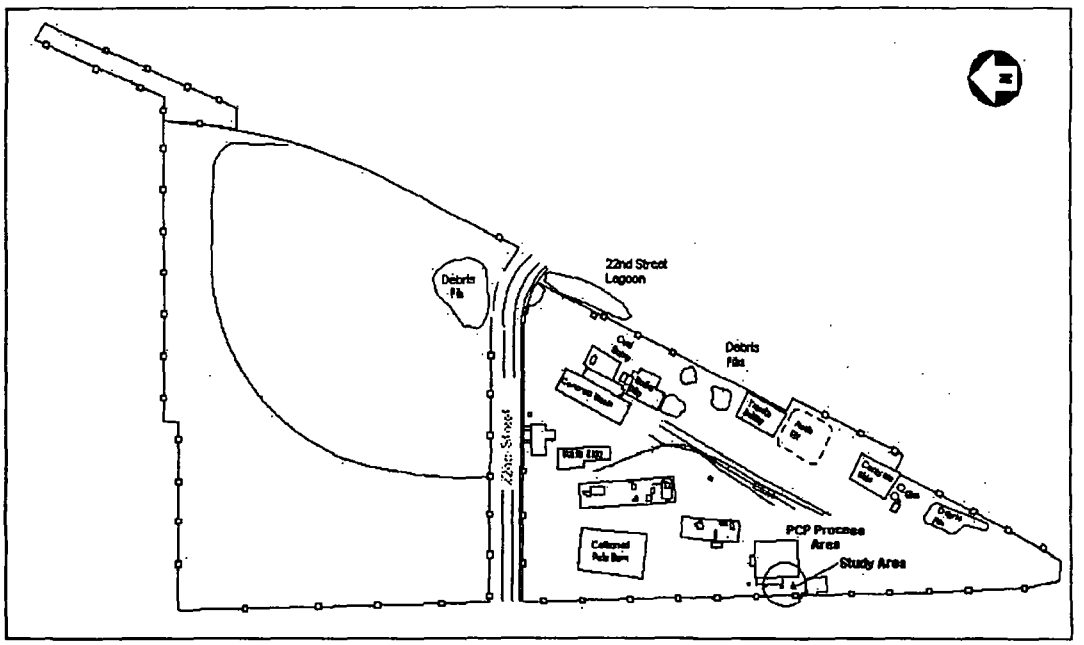


Figure 1 General Site Map

MATERIALS AND METHODS

During the 1990s, the Illinois Environmental Protection Agency (Illinois EPA) contracted Ecology and Environment, Inc. (E & E) to perform a series of investigations and a human health risk assessment to determine the extent of contamination and associated risk at the site. While both soil and groundwater were determined to have chemical concentrations that exceeded the site-specific risk-based criteria, E & E recommended the use of an in-situ biological agent to address the dissolved-phase PCP

(E & E, 1999). Additionally, Illinois EPA adopted the Maximum Contaminant Level (MCL) of 1 microgram per liter (µg/L) for PCP as a specific groundwater cleanup objective in their Record of Decision for the JW site (Illinois EPA 2000).

Because of its cost-effectiveness and success at remediating PCP in various laboratory studies, HRC® was the technology selected by E & E to treat the existing PCP groundwater contamination levels. Based on E & E's recommendation, the Illinois EPA subsequently authorized a pilot test using HRC® to be conducted at the JW site.

Pilot Test Application. On June 19, 2001, E & E mobilized to the JW site to perform the HRC® injection. HRC® was applied via seven injection points, with approximately 150 pounds of HRC® injected into each point. Figure 2 shows the location of the injection points and sampling points for the pilot study.

HRC® was injected into two rows of points located upgradient of existing monitoring well MW-8S and perpendicular to groundwater flow. The center points of the rows were approximately 3 and 5 feet upgradient of MW-8S. One hundred fifty (150) pounds of HRC® were injected at each point, from 27 to 17 feet BGS.

The HRC® material was injected into the saturated zoned through steel rods using a piston pump. Specifically, a geoprobe direct-push system and high-pressure piston-drive grout pump were used to inject the HRC®. A steel probe rod fitted with an expendable tip was advanced to the proposed depth of 27 feet BGS. The probe rod was slightly retracted to dislodge the expendable tip. The HRC® was then pumped through the open-ended probe rod into the soil as the rod was retracted. The rods were completely removed from the soil and the upper 17 feet of the open probe hole were backfilled with bentonite to form a seal between the ground surface and the HRC®. Upon completion of HRC® injection, all rods were removed and no physical pipe or conduit remained in the ground. This process was repeated at each of the injection points.

Sampling and Analysis. Five individual groundwater sampling rounds were performed, with the first round of sampling occurring prior to HRC® injection to establish a basis for evaluating the effectiveness of HRC® in eliminating PCP contamination.

For each round of sampling, a groundwater sample was collected from MW-8S. For rounds 2 through 4, a geoprobe was used to collect additional groundwater samples from upgradient and downgradient locations. Figure 2 shows the geoprobe locations relative to MW-8S.

Groundwater samples were collected using low-flow sampling techniques. A peristaltic pump and disposable polyethylene tubing were used to purge and collect the samples. The tubing intake was placed near the midpoint of the saturated screen interval for samples collected from MW-8S. For samples collected using the geoprobe, groundwater-sampling rods were driven to a depth of 22 feet BGS, approximately the same depth interval as the midpoint for MW-8S.

Groundwater was purged at a rate of approximately 0.5 L/min and monitored for the stabilization of temperature, specific conductance, pH, turbidity, and dissolved oxygen (DO). Upon stabilization of these parameters, the pumping rate was reduced, and the groundwater sample was collected. All groundwater samples were analyzed for volatile organic compounds, semivolatile organic compounds, total iron, total manganese,

alkalinity, anions (chloride, nitrate-N, and sulfate), dissolved gases (methane, ethane, ethene, and total and free carbon dioxide), sulfide, pH, and total organic carbon (TOC).

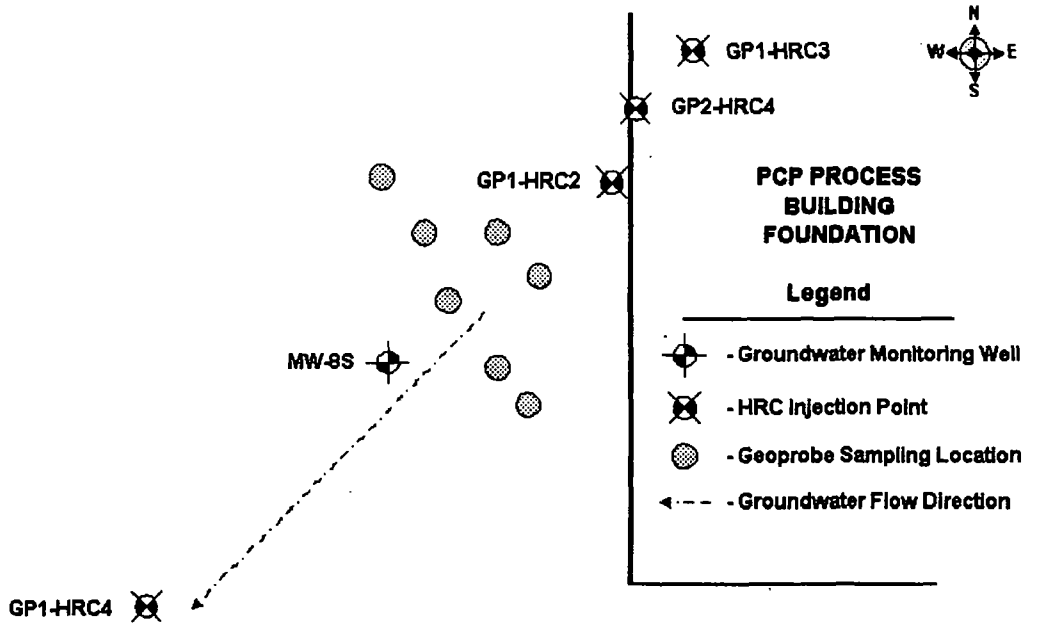


Figure 2 HRC® Injection Points and Sampling Locations

For sampling rounds 4 and 5, the groundwater samples were also submitted for metabolic acids analysis.

RESULTS AND DISCUSSION

Groundwater was analyzed for a period of 261 days following the HRC® application. Upon application of HRC® to the pilot test area, PCP levels in monitoring well MW-8S steadily decreased throughout the course of the monitoring program. All in all, PCP levels dropped from 104 mg/L at baseline to 1.9 mg/L at day 261, representing a decrease of 98%. Tables 1 and 2 provides a summary of select field and laboratory analytical results, and Figure 3 presents the PCP concentration in MW-8S over the course of the pilot study.

DO levels decreased following the HRC® application, going from 8.5 mg/L at baseline to 0.3 mg/L at day 261. This significant drop in DO levels indicates that HRC® was able to create and sustain a reduced environment in the area of application. TOC and metabolic acid levels remained elevated throughout the course of the monitoring program. The presence of TOC and metabolic acids (acetic acid, butyric acid, lactic acid, propionic acid, and pyruvic acid) provides evidence of the presence of the HRC® reducing power near the sampled monitoring well.

Table 1 Summary of Field and Analytical Results for MW-8S

Analyte	Location / Collection Date	MW-8S 6/19/1	8/1/01	9/5/01	11/7/01	3/7/02
Volatile Organic Compounds (micrograms/liter)						
2-Butanone		28.5	32.6	24.1	24.9	7.45 J
Benzene-Ethylbenzene-Toluene-Xylene		245.7	238.7	256.3	269.04	9.04
Trichloroethene		6.62	6.31	8.18	11.5	2.58 J
Semivolatile Organic Compounds (micrograms/liter)						
2,4,6-Trichlorophenol		5.20 J	ND	ND	ND	ND
2-Methylnaphthalene		520 E	477 J	436 J	531	64 J
Pentachlorophenol		104,000	101,100	83,200	54,300 J	1,910
Metals (milligrams per liter)						
Dissolved Iron		38,200	36,900	34,600	43,000	4,180
Dissolved Manganese		4,350	4,650	4,550	5,270	287
Field Parameters						
Turbidity (nephelometric turbidity units)		68	35.2	MF	320	42
Dissolved Oxygen (milligrams/liter)		8.46	0	1.4	0.68	0.3
Total Dissolved Solids (grams/liter)		0.7	0.7	0.7	0.7	0.4
Oxidation-Reduction Potential (millivolts)		-87	-131	-80	-99	-119

Key:
J = Estimated Concentration. ND = Not Detected. MF = Meter Failure. E = Exceeds calibration limits.

Table 2 Summary of Field and Analytical Results for Geoprobe Locations

Analyte	Location / Collection Date	GP1-HRC2 8/1/01	GP1-HRC3 9/5/01	GP1-HRC4 11/7/01	GP2-HRC4 11/7/01
Volatile Organic Compounds (micrograms/liter)					
2-Butanone		11.2	7.31 J	84.0	ND
Benzene-Ethylbenzene-Toluene-Xylene		236.44	136.83	299.6	113.31
Trichloroethene		5.17	5.89	12.6	7.11
Semivolatile Organic Compounds (micrograms/liter)					
2,4,6-Trichlorophenol		ND	ND	ND	ND
2-Methylnaphthalene		410 J	ND	451 J	316
Pentachlorophenol		100,000	30,600 E	54,700 J	26,400
Metals (milligrams/liter)					
Dissolved Iron		31,800	52.5	29,100	18,900
Dissolved Manganese		89.2	2.7	5,500	3,040
Field Parameters					
Turbidity (nephelometric turbidity units)		34.7	MF	270	220
Dissolved Oxygen (milligrams/liter)		0	1	0.58	0.46
Total Dissolved Solids (grams/liter)		0.57	0.6	0.7	0.54
Oxidation-Reduction Potential (millivolts)		-128	-81	-109	-74

Key:
J = Estimated Concentration. ND = Not Detected. MF = Meter Failure. E = Exceeds calibration limits.

Based on further review of the analytical data, no decomposition products associated with the dechlorination of PCP were detected after the HRC injection. While 2,4,6-trichlorophenol was initially detected in the baseline groundwater sample collected from MW-8S, 2,4,6-tricholorphenol was not detected in any subsequent groundwater sample collected from either MW-8S or any of the upgradient or downgradient samples.

Finally, the concentration of trichloroethene in the sample collected at day 261 showed a significant drop when compared to the initial baseline sample.

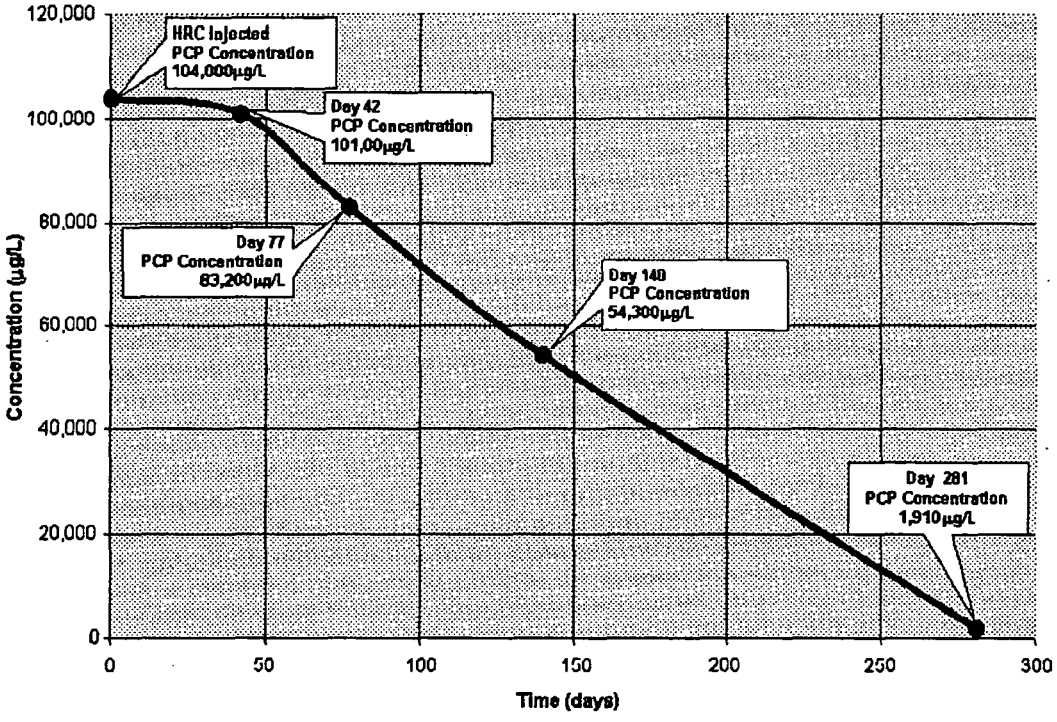


Figure 3 PCP Concentration Graph for MW-8S

CONCLUSIONS

Based on the results of the pilot test, the injection of HRC® into the upper aquifer at the JW site created anaerobic conditions. Under these conditions, PCP concentrations decreased from 104 mg/L to < 2 mg/L. Given that the MCL and groundwater cleanup objective for PCP at the JW site is 0.001 mg/L, a final determination as to whether HRC® can achieve groundwater closure cannot be made at this time. However, the pilot test did prove that elevated PCP groundwater concentrations can be effectively reduced using HRC®. Additionally, the analytical results did not indicate any degradation products associated with dechlorination of PCP, which indicates that full dechlorination of the phenol radical may have occurred as well as cleavage of the benzene ring.

While there was a reduction in the trichloroethene concentration, there is insufficient data to determine whether biological degradation associated with the

stimulated anaerobic conditions was the main factor associated with the concentration reduction.

Based on the findings of the pilot test, the Illinois EPA has authorized a full-scale design for injecting HRC® across the JW site to address dissolved-phased PCP.

REFERENCES

Bergstrom, R. E., and T.R. Walker, 1956, *Groundwater Geology of the East St. Louis Area, Illinois*, Illinois State Geological Survey Report Investigation 191.

Ecology and Environment, Inc., (E & E), July 1999, *Engineering Evaluation/Cost Analysis Report, Jennison-Wright Site, Granite City, Illinois.*

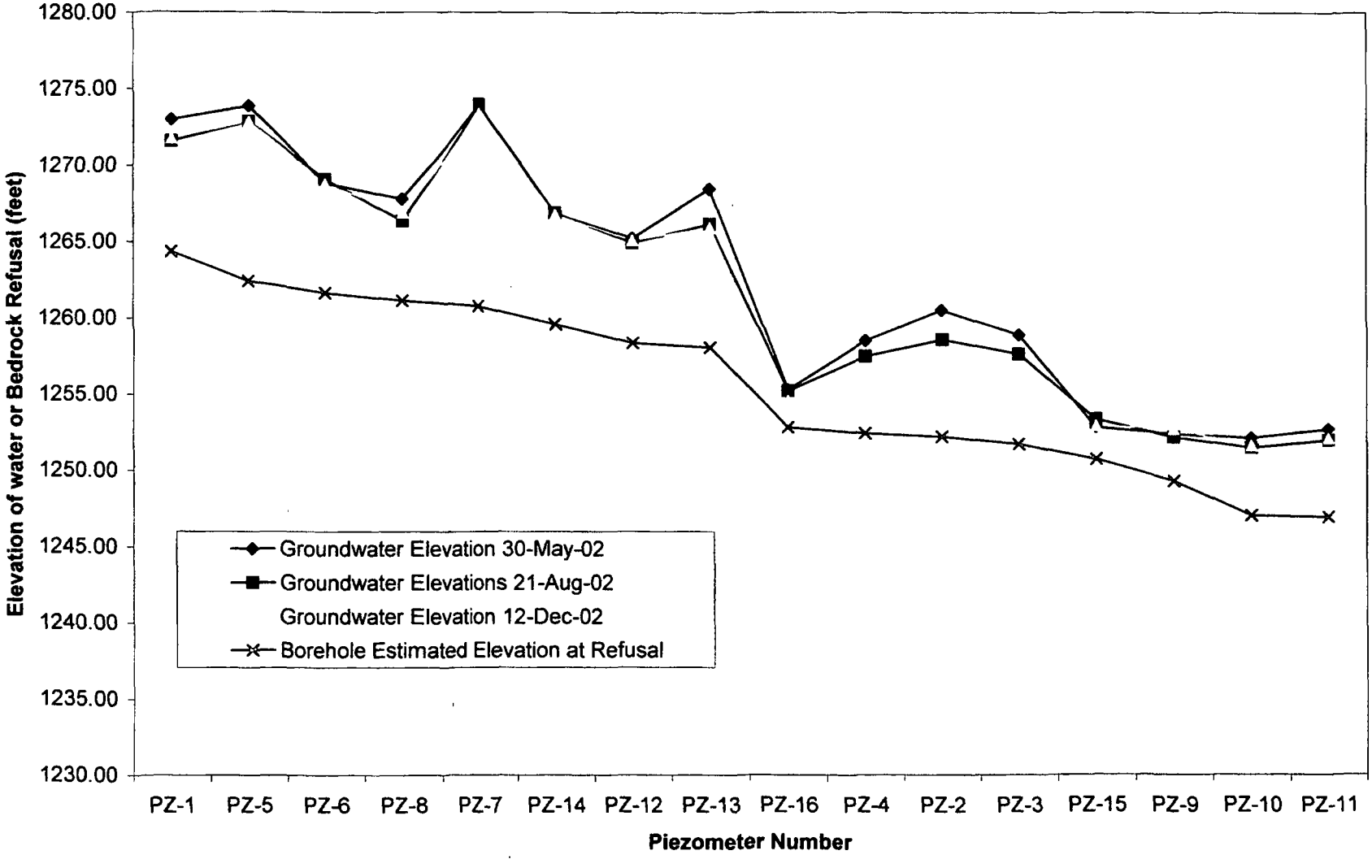
_____, (E & E), January 18, 1985, *Compliance Investigation Report.*

Illinois Environmental Protection Agency (Illinois EPA), September 29, 2000, *Declaration for the Record of Decision*, Jennison-Wright Superfund Site, Granite City, IL.

Woodward-Clyde Consultants (WCC), August 1988, *Site Assessment Report, The Jennison-Wright Corporation, Granite City, Illinois.*

FIGURE 1

Comparison of Groundwater Levels by Location Up to Down Gradient



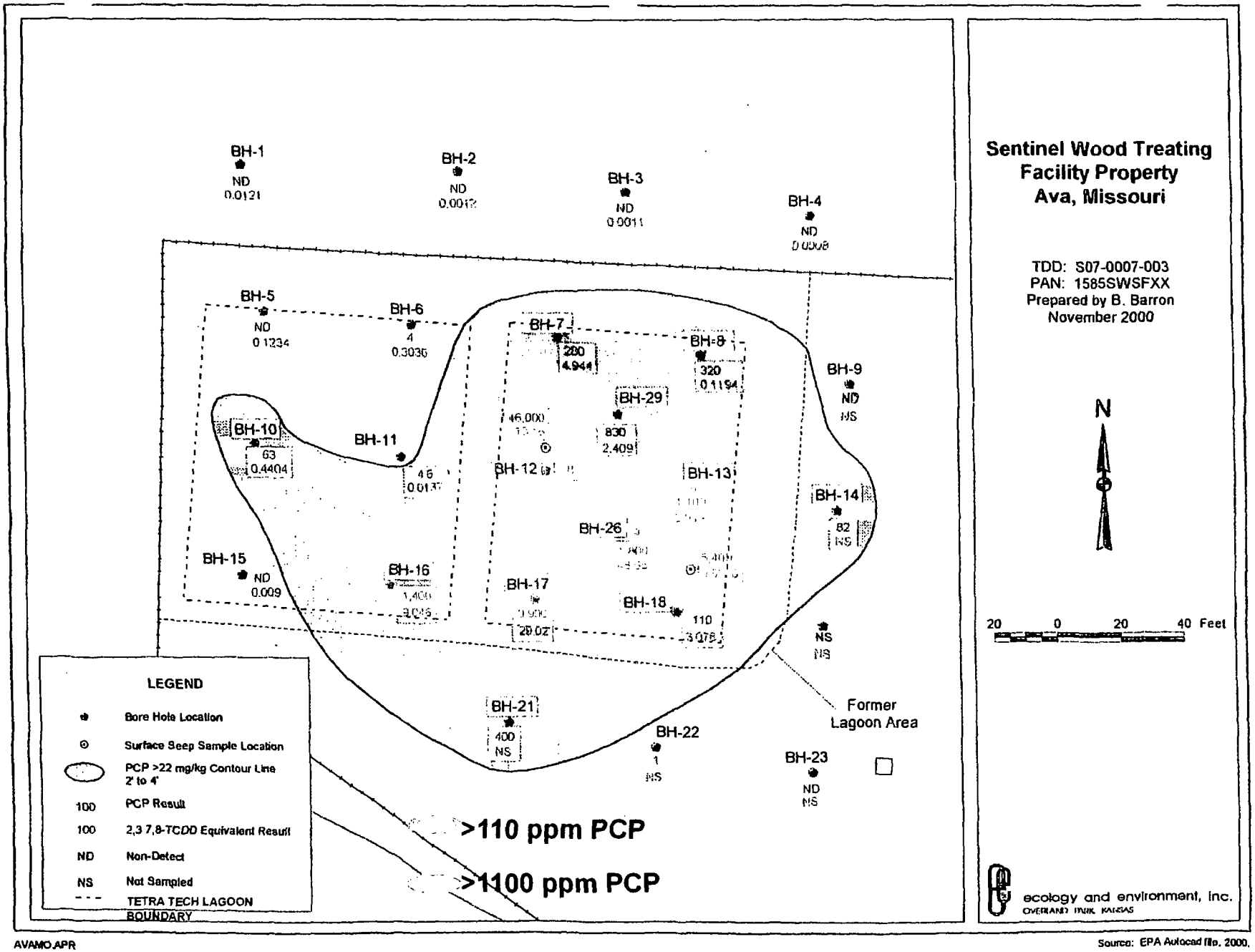


Figure 6: EPA Removal Assessment Sampling in Lagoon Area
PCP and Dioxin Results at the 2' to 4' Interval

FIGURE 2

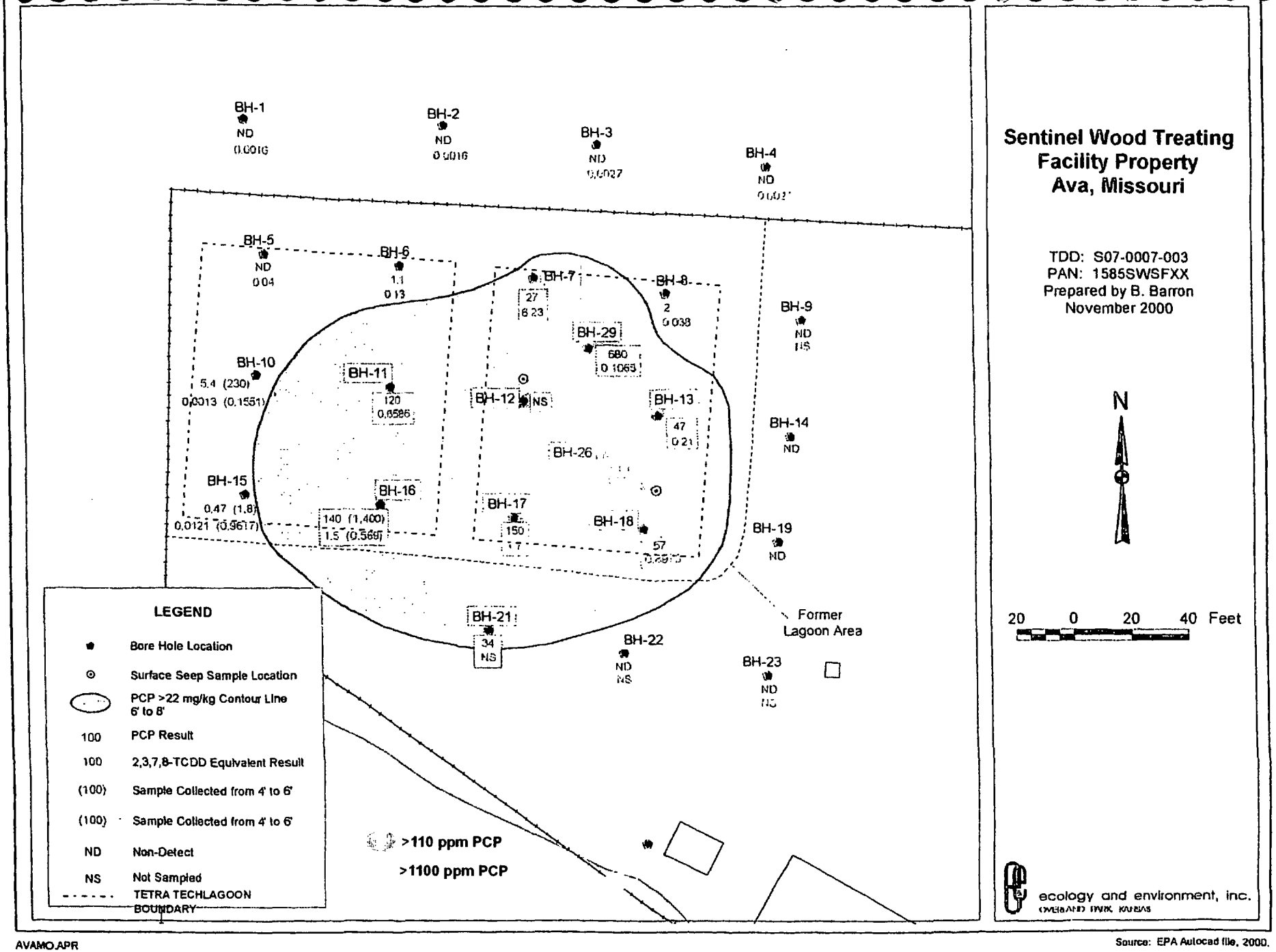


Figure 7: EPA Removal Assessment Sampling in Lagoon Area
PCP and Dioxin Results at the 6' to 8' Interval

FIGURE 3

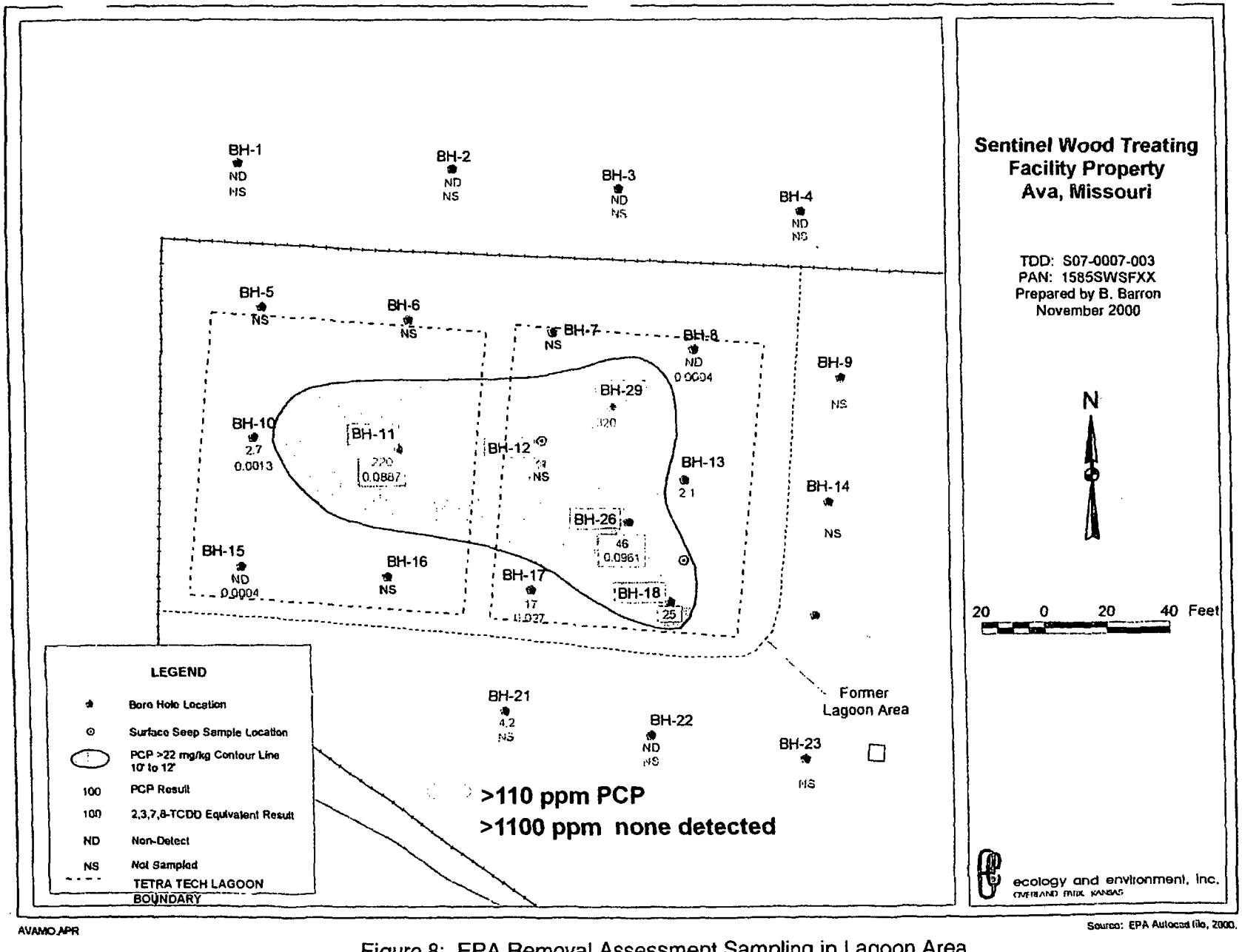


Figure 8: EPA Removal Assessment Sampling in Lagoon Area
PCP and Dioxin Results at the 10' to 12' Interval

FIGURE 4

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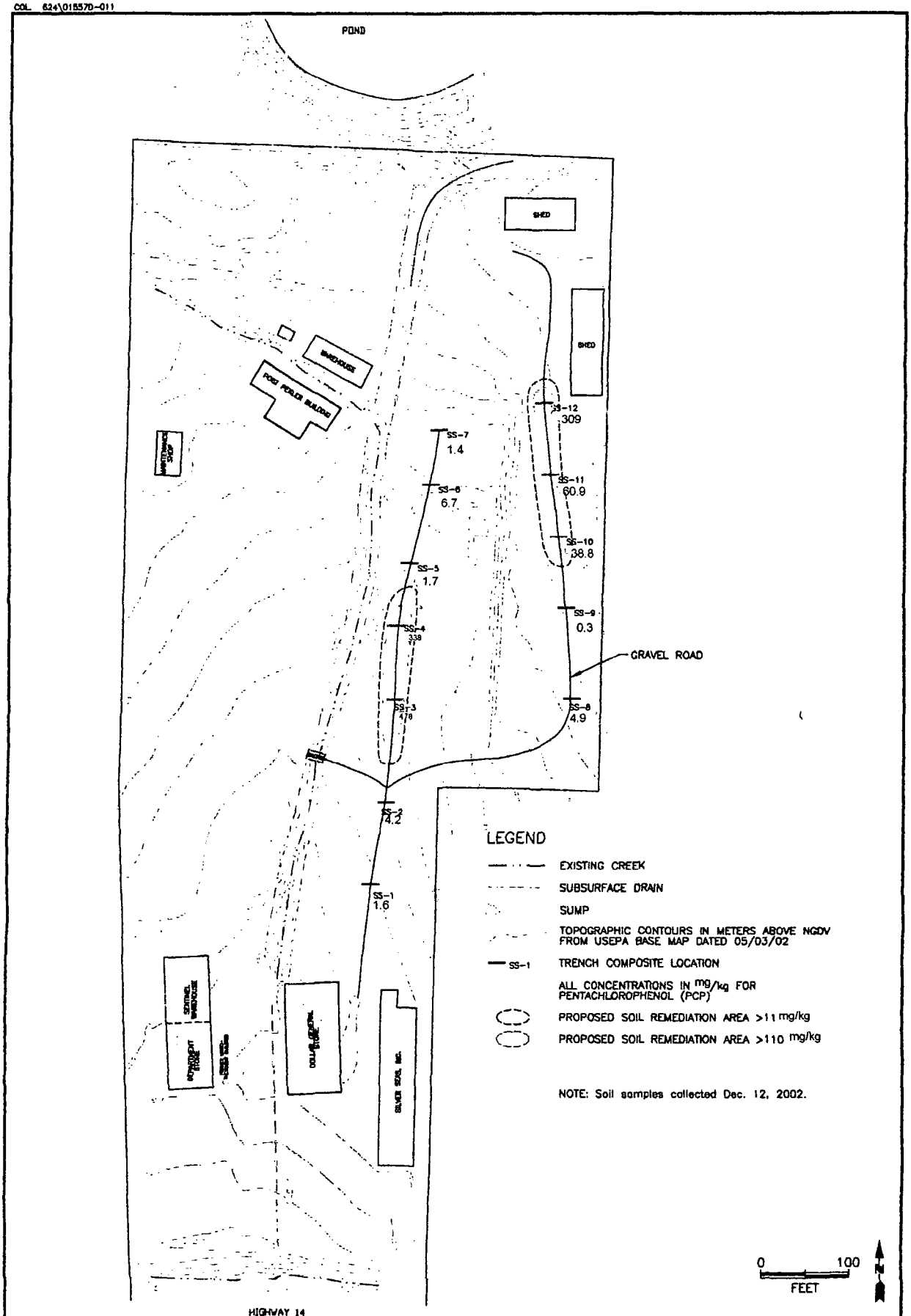


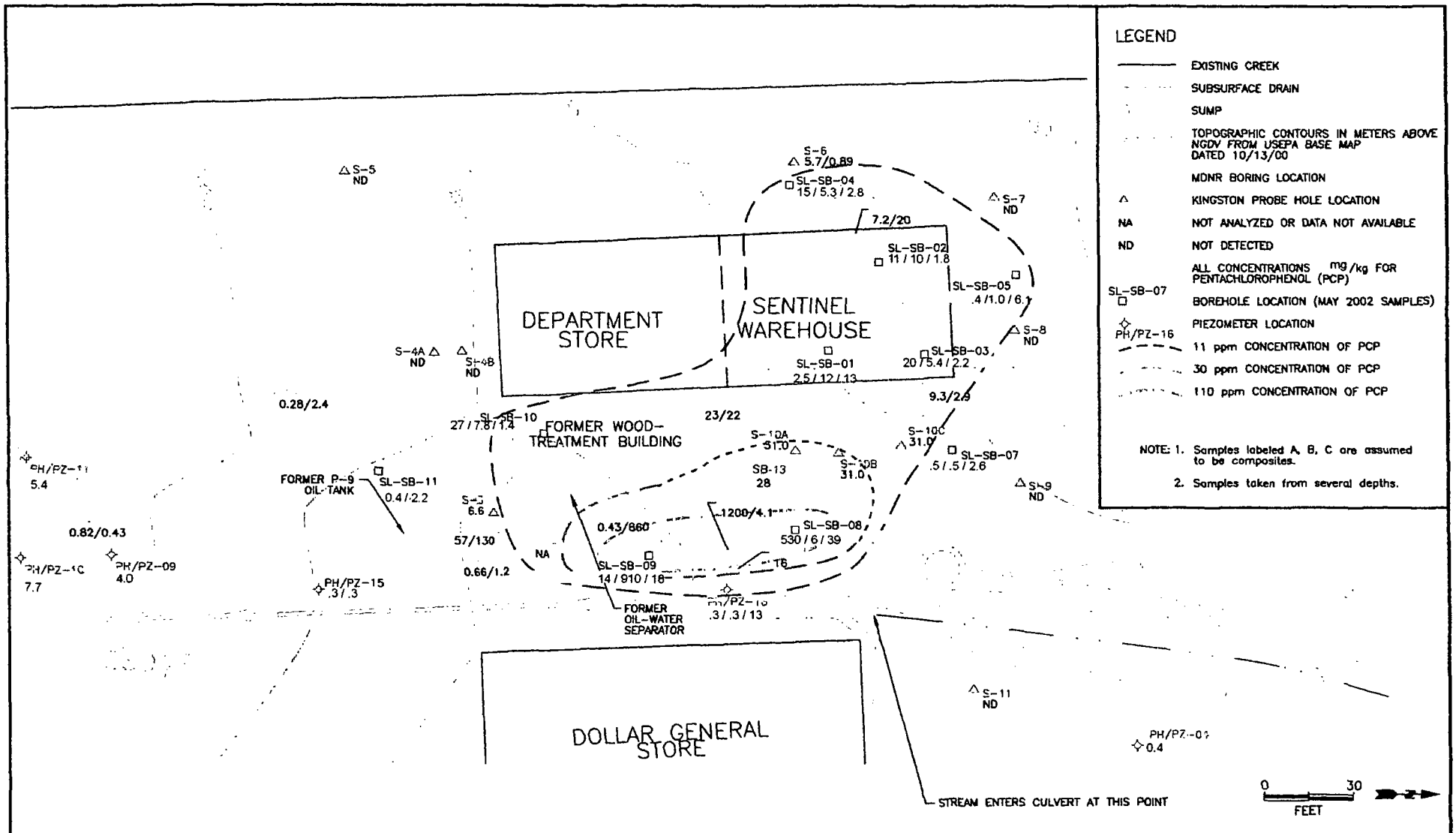
PSC

TITLE: SOIL PENTACHLOROPHENOL CONCENTRATIONS AND PROPOSED ROAD SOIL REMEDIATION LOCATIONS

DRN:	DES.:
TMM	DEM
CHKD:	APPD:
DATE: 9/30/03	REV.: 0

PROJECT NO.: 62401557
SENTINEL WOOD TREATING
AVA, MISSOURI

FIGURE 5

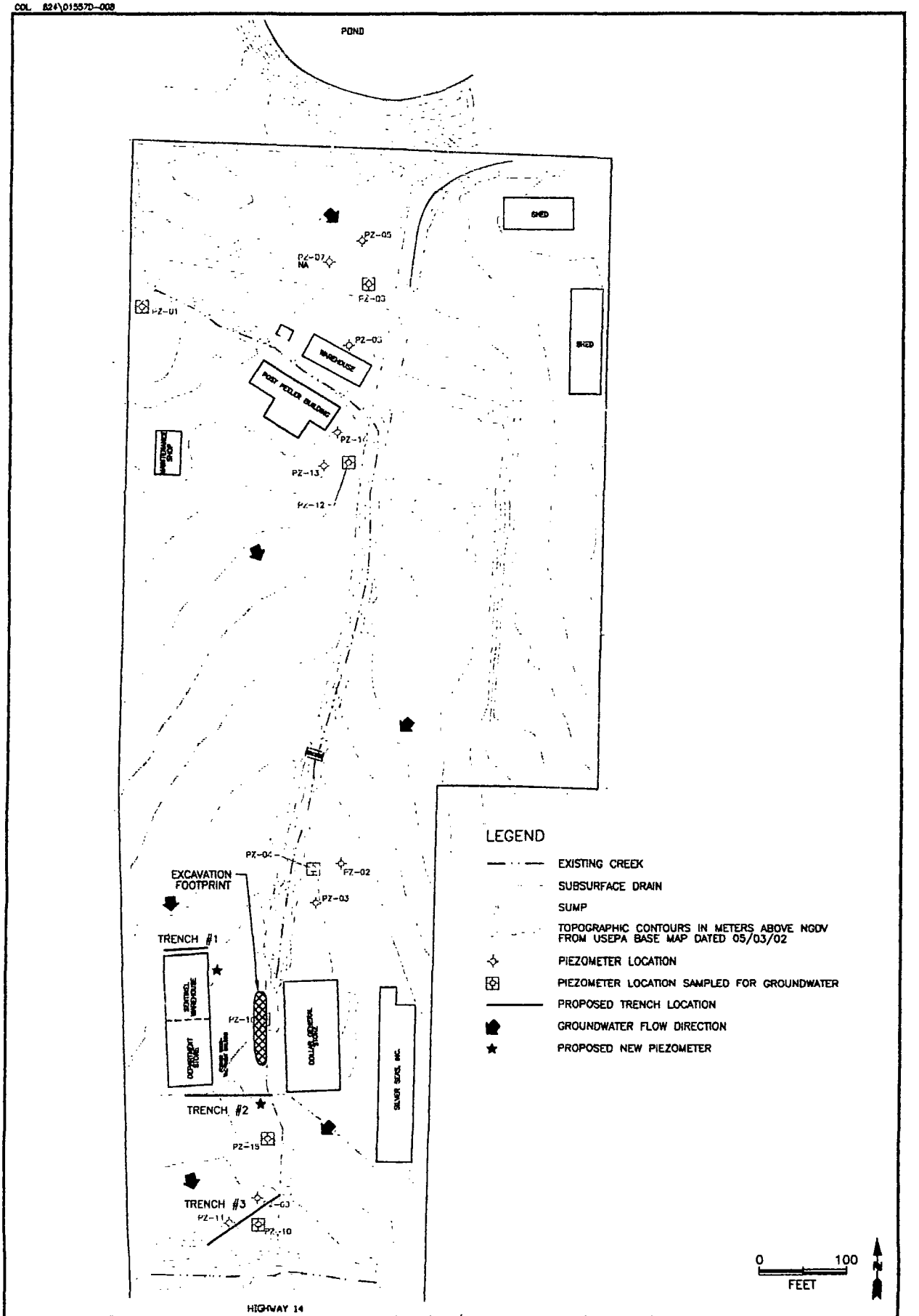


TITLE:
FORMER WOOD TREATMENT AREA
ISOPLETHS OF PENTACHLOROPHENOL SOIL CONCENTRATIONS

DRN: RR	DES:	PROJECT NO: 62401557	SENTINEL WOOD TREATING AVA, MISSOURI
CHKD:	APPD:		
DATE: JULY 04	REV: 1	FIGURE 6	

62A\018570-014

COL 824\015570-008



PSC

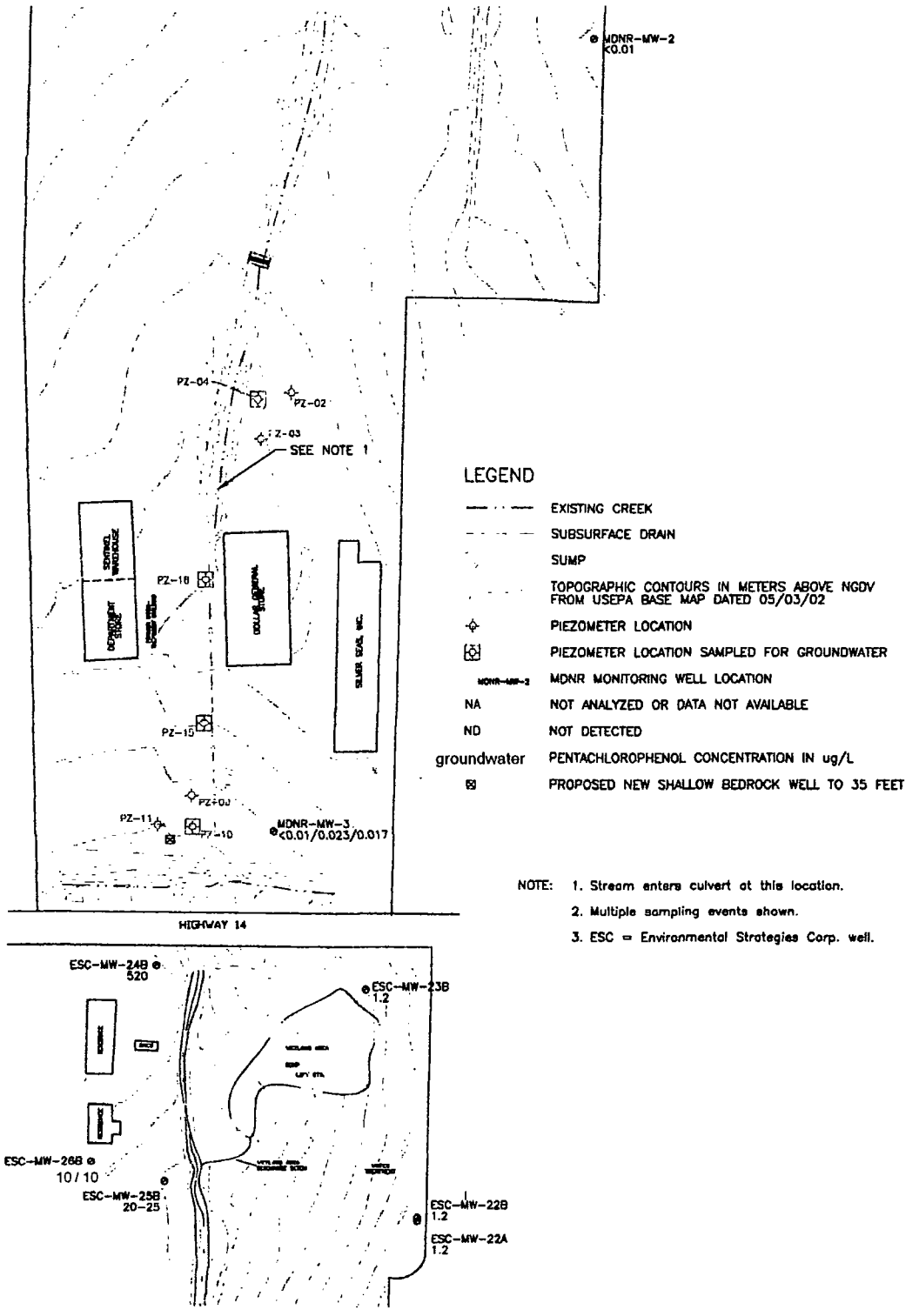
TITLE:
PROPOSED REMEDIATION EXCAVATION AND TRENCH LOCATIONS IN FORMER WOOD TREATMENT AREA

DRN:	DES.:
TMM	DEM
CHKD:	APPD:
DATE: 10/1/03	REV.: 0

PROJECT NO.: 62401557
SENTINEL WOOD TREATING
AVA, MISSOURI

FIGURE 7

COL 624\01557D-012

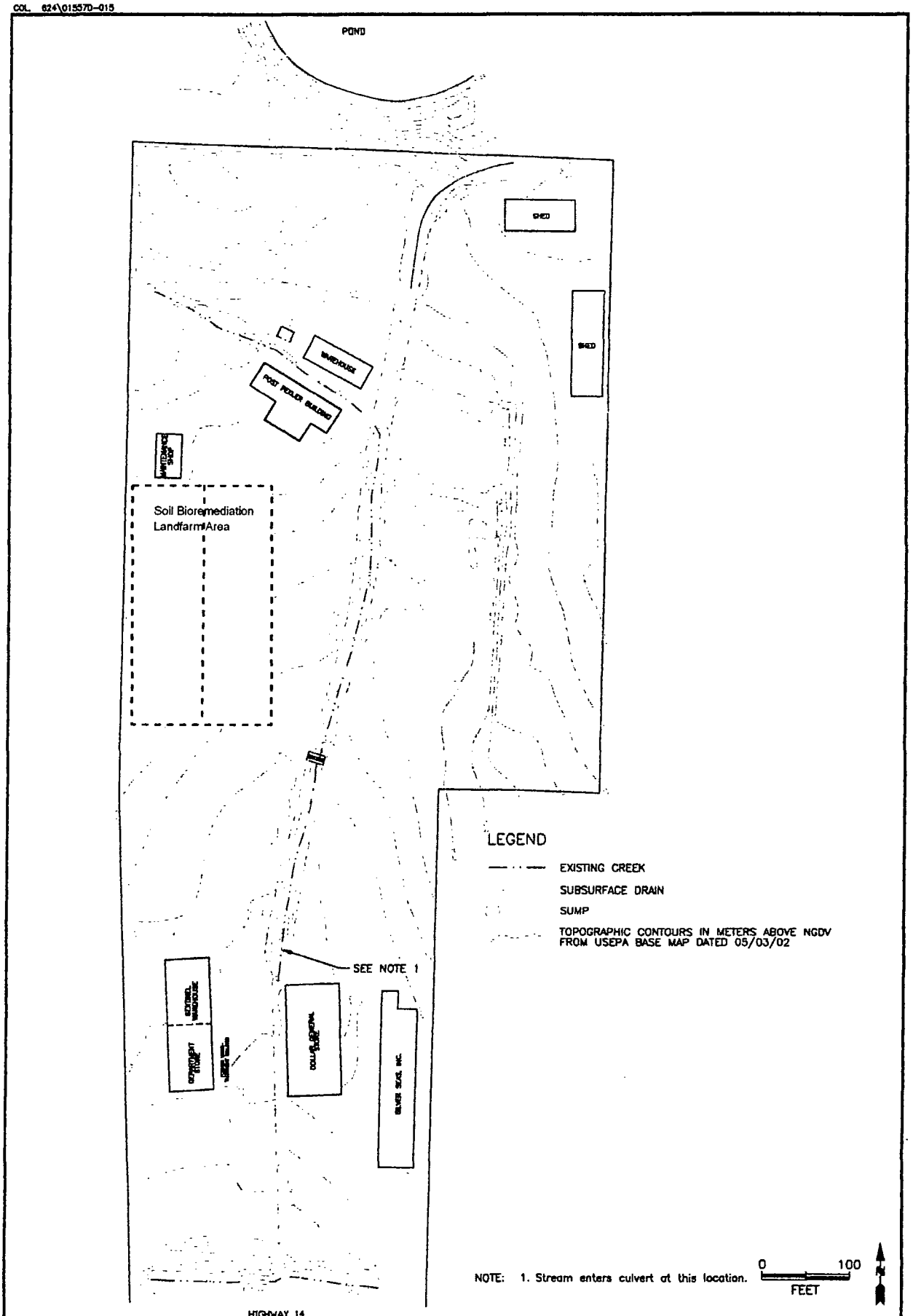


PSC

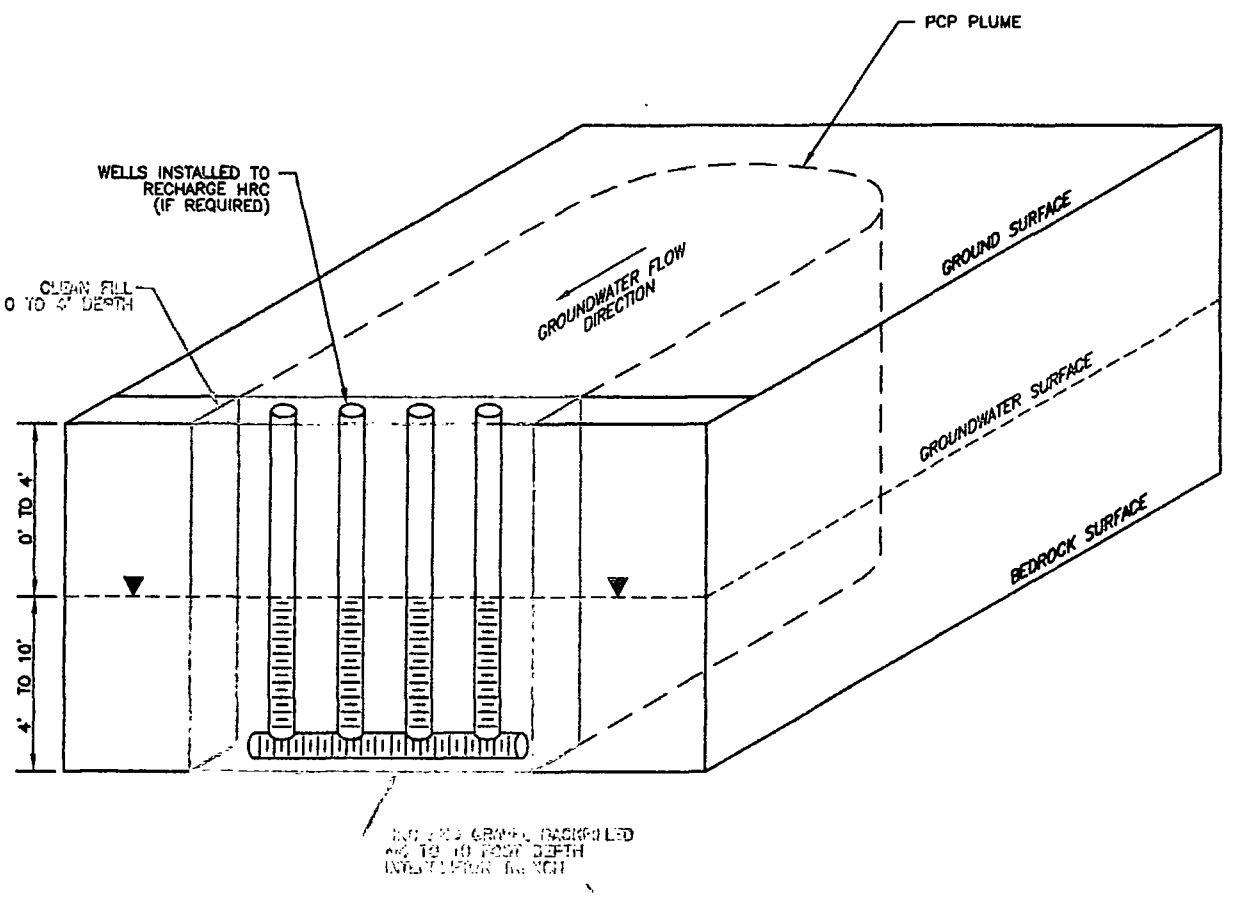
TITLE:
GROUNDWATER PENTACHLOROPHENOL CONCENTRATIONS FOR DOWNGRADIENT WELLS ON MERRITT PROPERTY PARTS PER BILLION

DRN:	DES.:	PROJECT NO.: 62401557
CHKD:	APPD:	SENTINEL WOOD TREATING AVA, MISSOURI
DATE: 8/23/04	REV.:	FIGURE 8

COL. 624\01557D-015

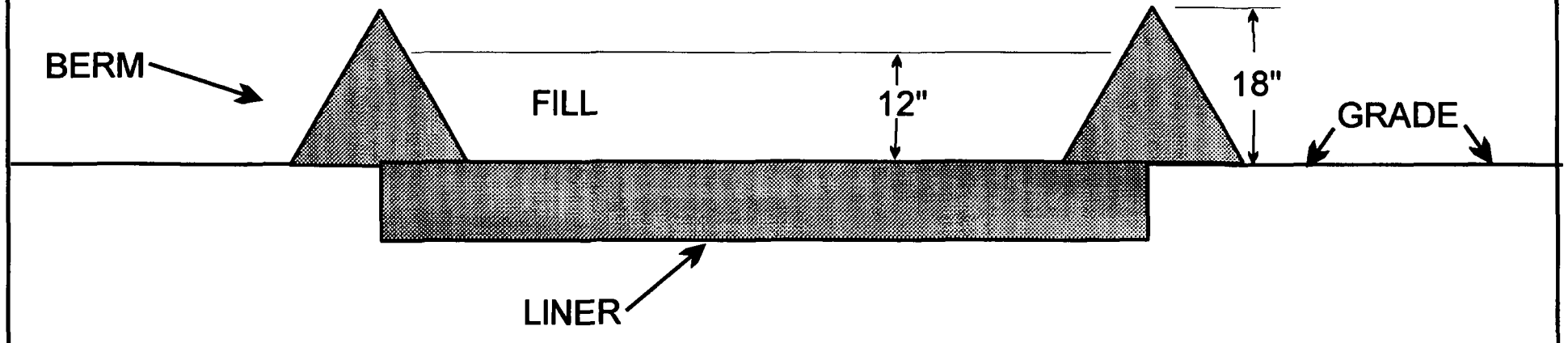


	TITLE: PROPOSED BIOREMEDIATION SITE CONSTRUCTION	DRN: RR	DES.:	PROJECT NO.: 62401557 SENTINEL WOOD TREATING AVA, MISSOURI
		CHKD:	APPD:	
		DATE: 7-31-04	REV.: 1	FIGURE 9



PSC	TITLE: SCHEMATIC OF HRC TREATMENT BARRIER	DWN: TMM	DES.: DEM	PROJECT NO.: 62401557 SENTINEL WOOD TREATING AVA, MISSOURI	
		CHKD:	APPD:		
		DATE: 9/30/03	REV.: 0	FIGURE 10	

CDL 824\015572E-001



BERM & LINER ARE OF THE SAME CLAY BENTONITE MIXTURE

CROSS SECTION OF BIOTREATMENT PAD
FIGURE 11

NO SCALE

BIOREMEDIATION TREATMENT CELL FIGURE 12

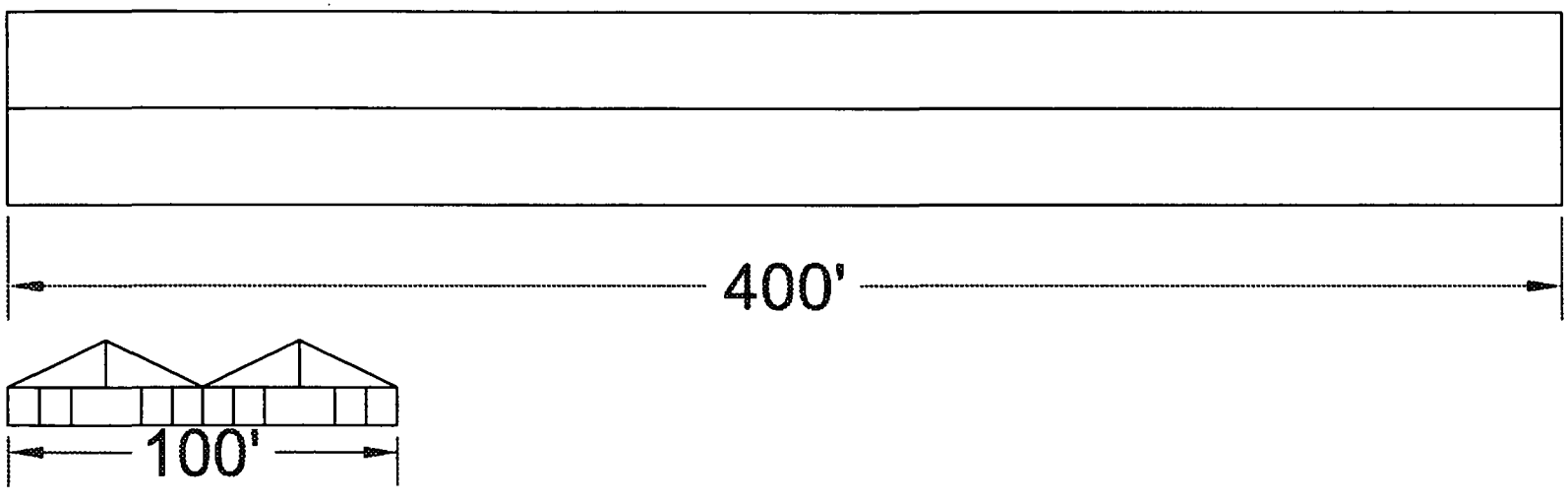


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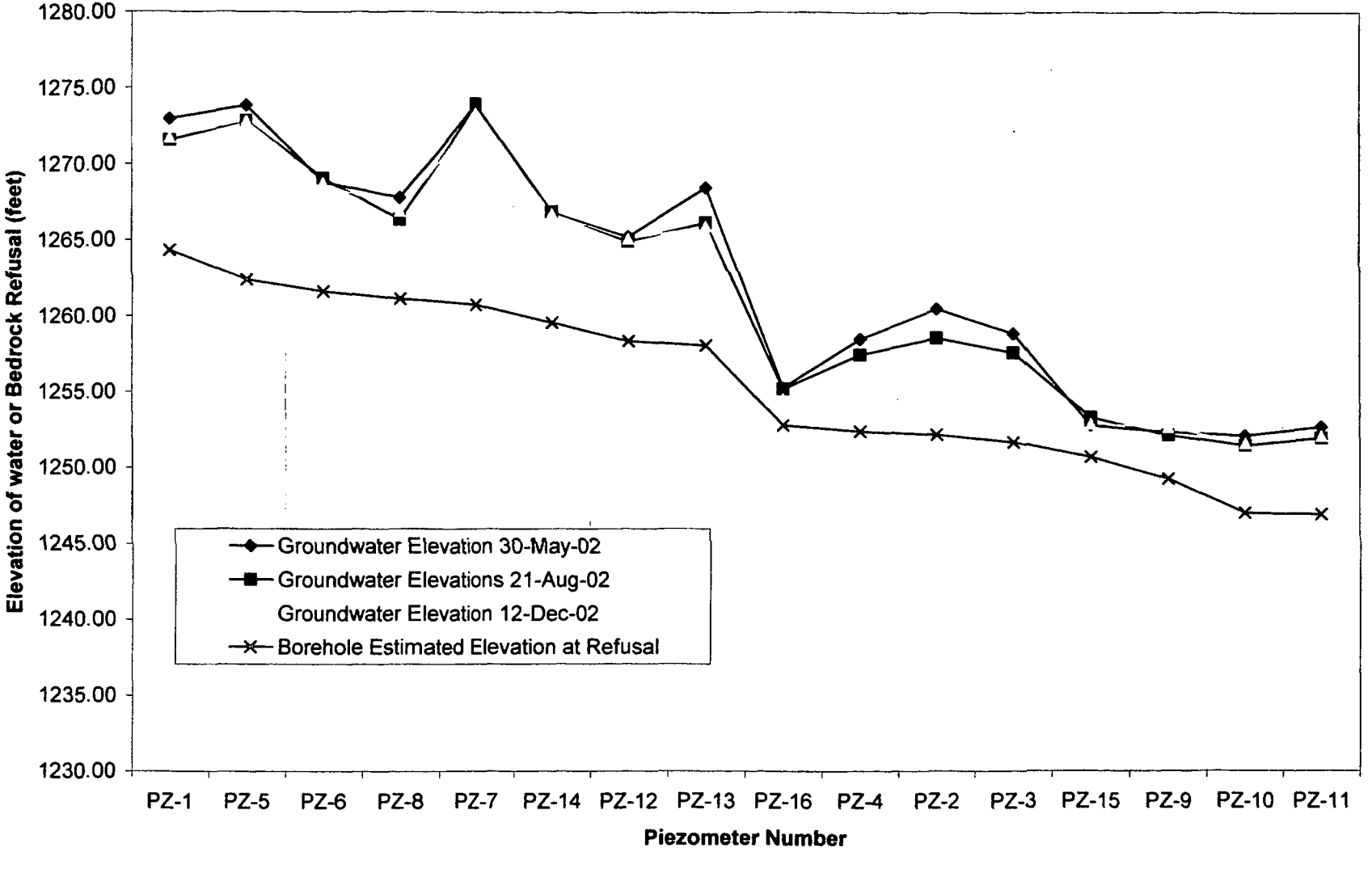
FIGURE 1

Comparison of Groundwater Levels by Location Up to Down Gradient



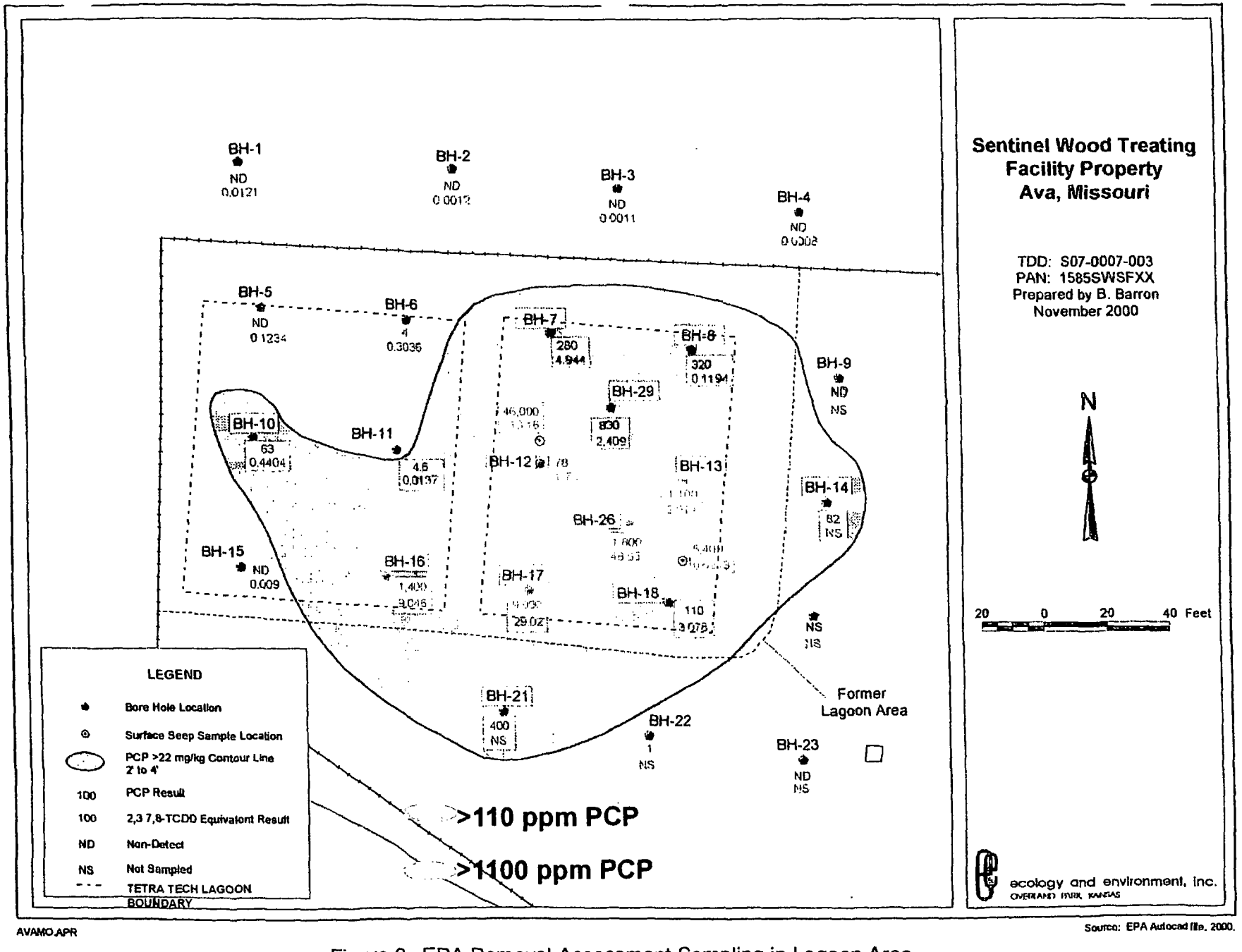


Figure 6: EPA Removal Assessment Sampling in Lagoon Area
PCP and Dioxin Results at the 2' to 4' Interval

FIGURE 2

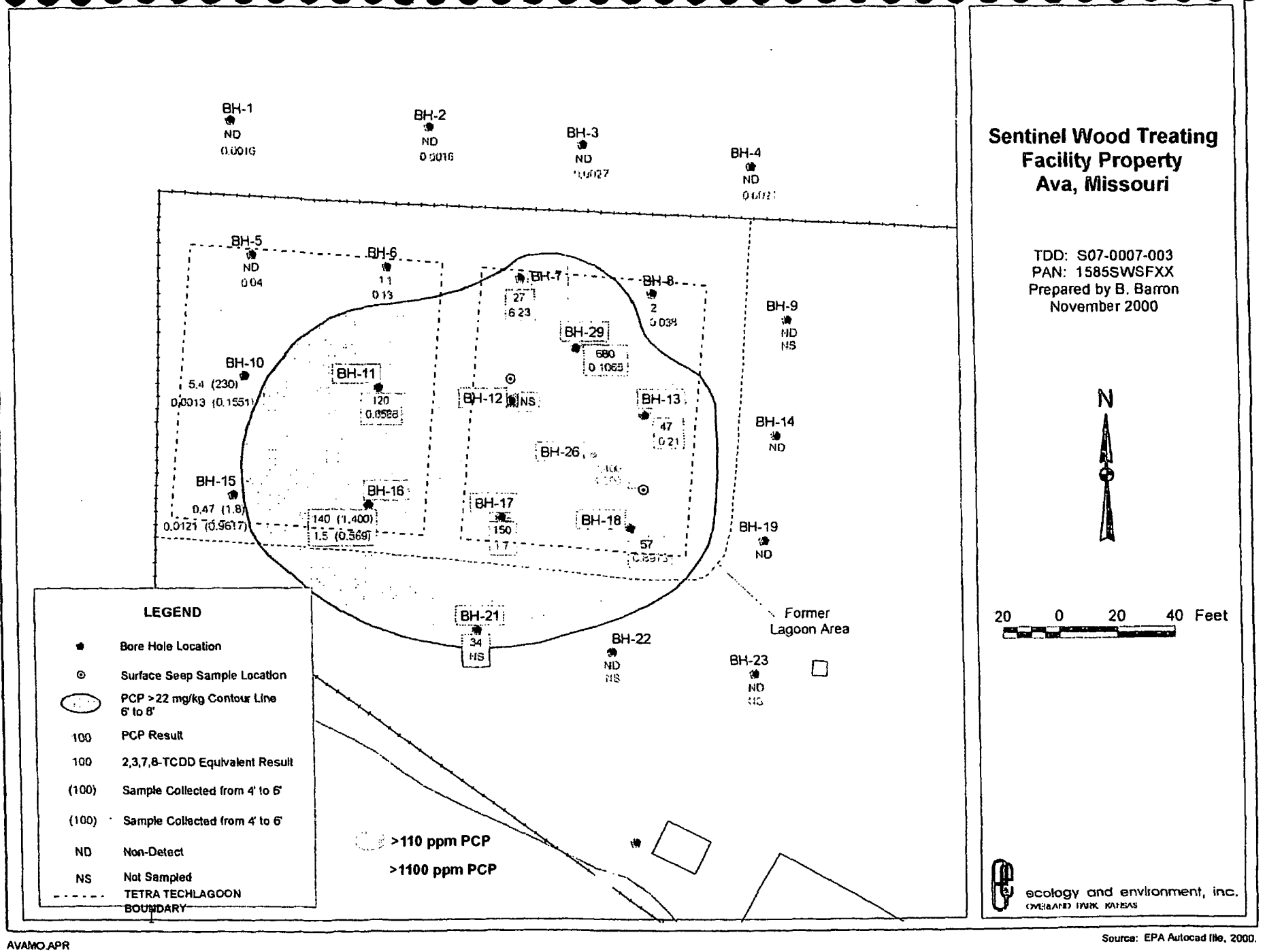


Figure 7: EPA Removal Assessment Sampling in Lagoon Area
PCP and Dioxin Results at the 6' to 8' Interval

FIGURE 3

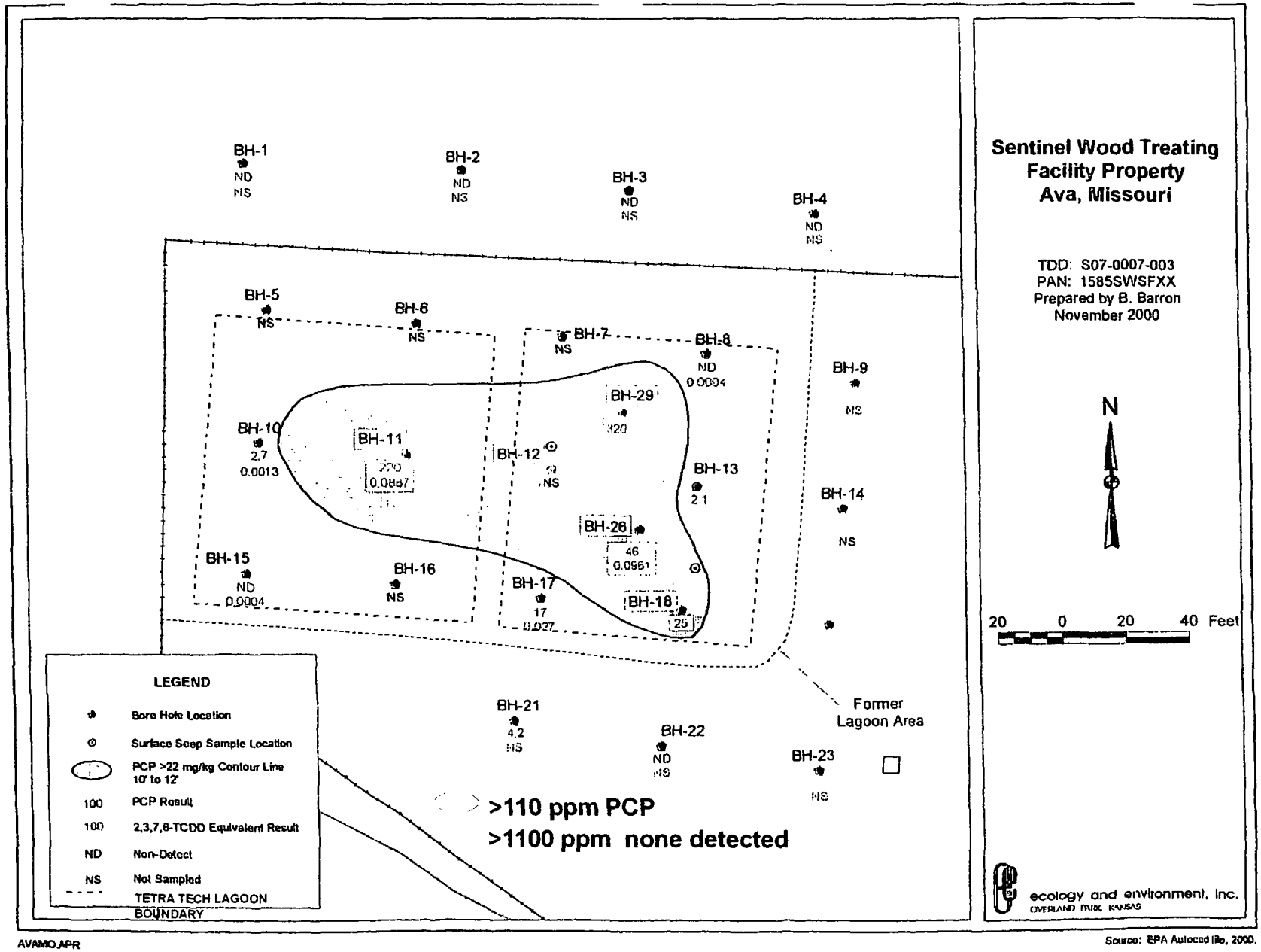
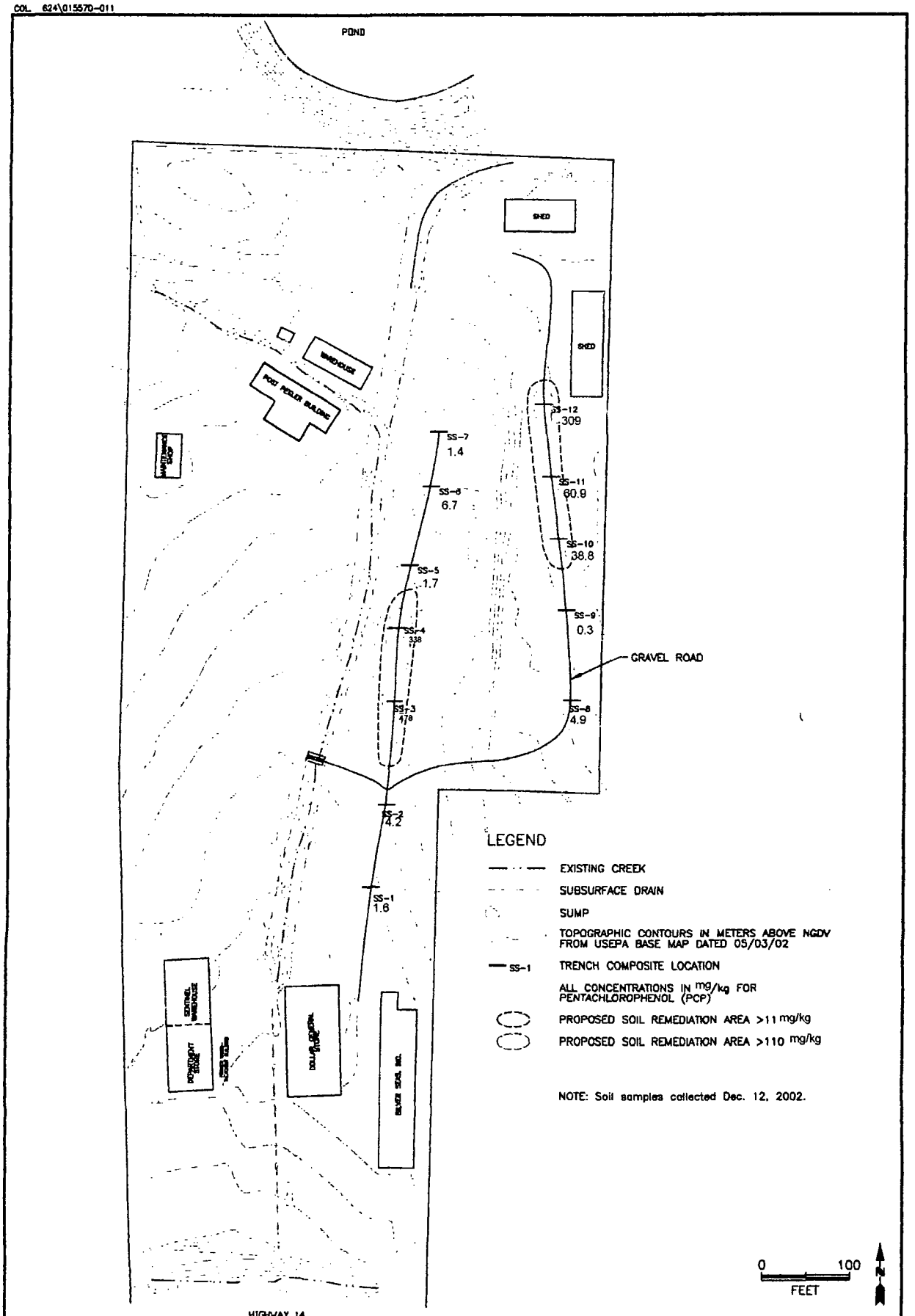


Figure 8: EPA Removal Assessment Sampling in Lagoon Area
PCP and Dioxin Results at the 10' to 12' Interval

FIGURE 4

COL. 624\015570-011



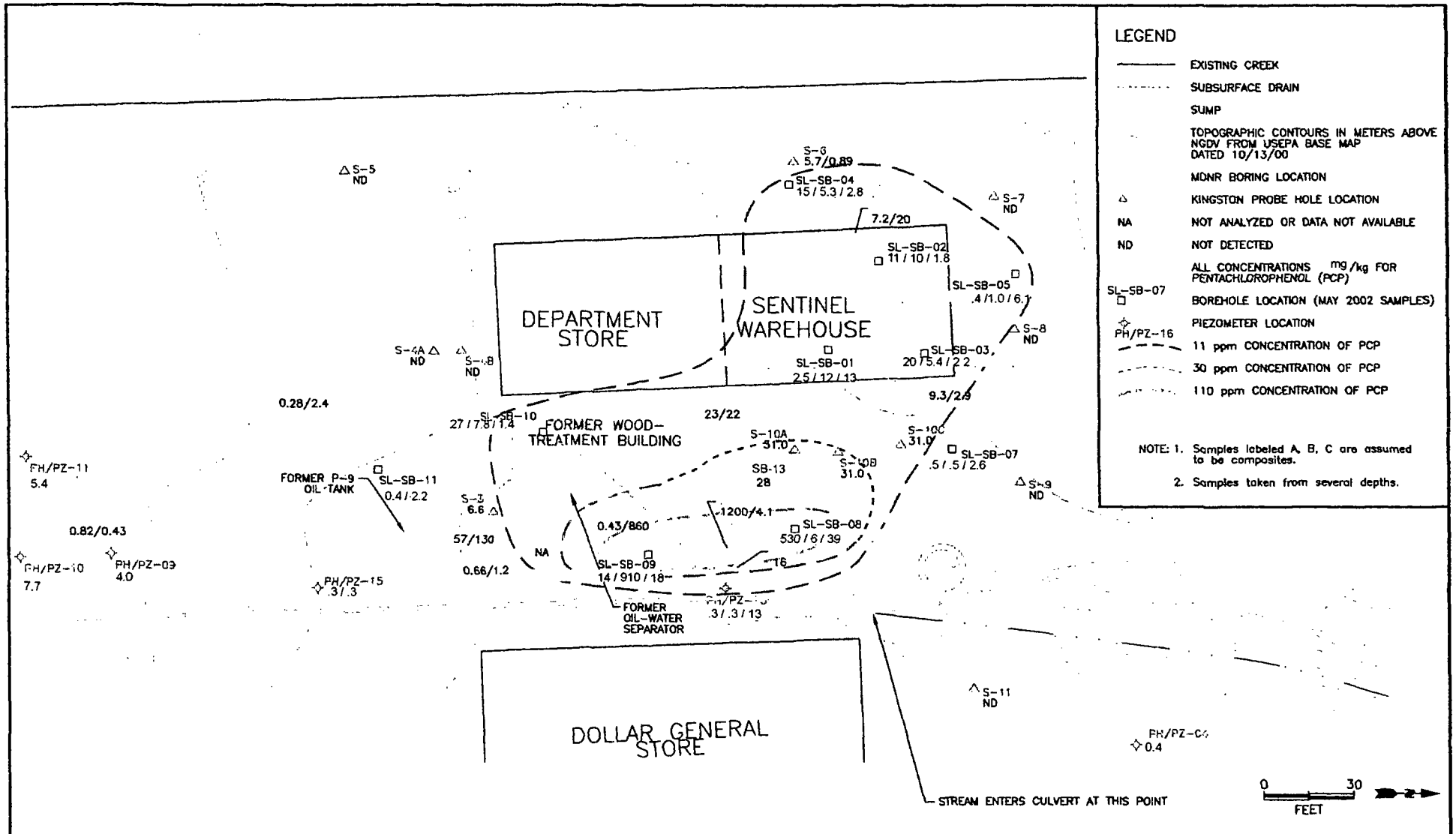
PSC

TITLE:
SOIL PENTACHLOROPHENOL CONCENTRATIONS AND PROPOSED ROAD SOIL REMEDIATION LOCATIONS

DWN:	DES.:
TMM	DEM
CHKD:	APPD:
DATE: 9/30/03	REV.: 0

PROJECT NO.: 62401557
SENTINEL WOOD TREATING
AVA, MISSOURI

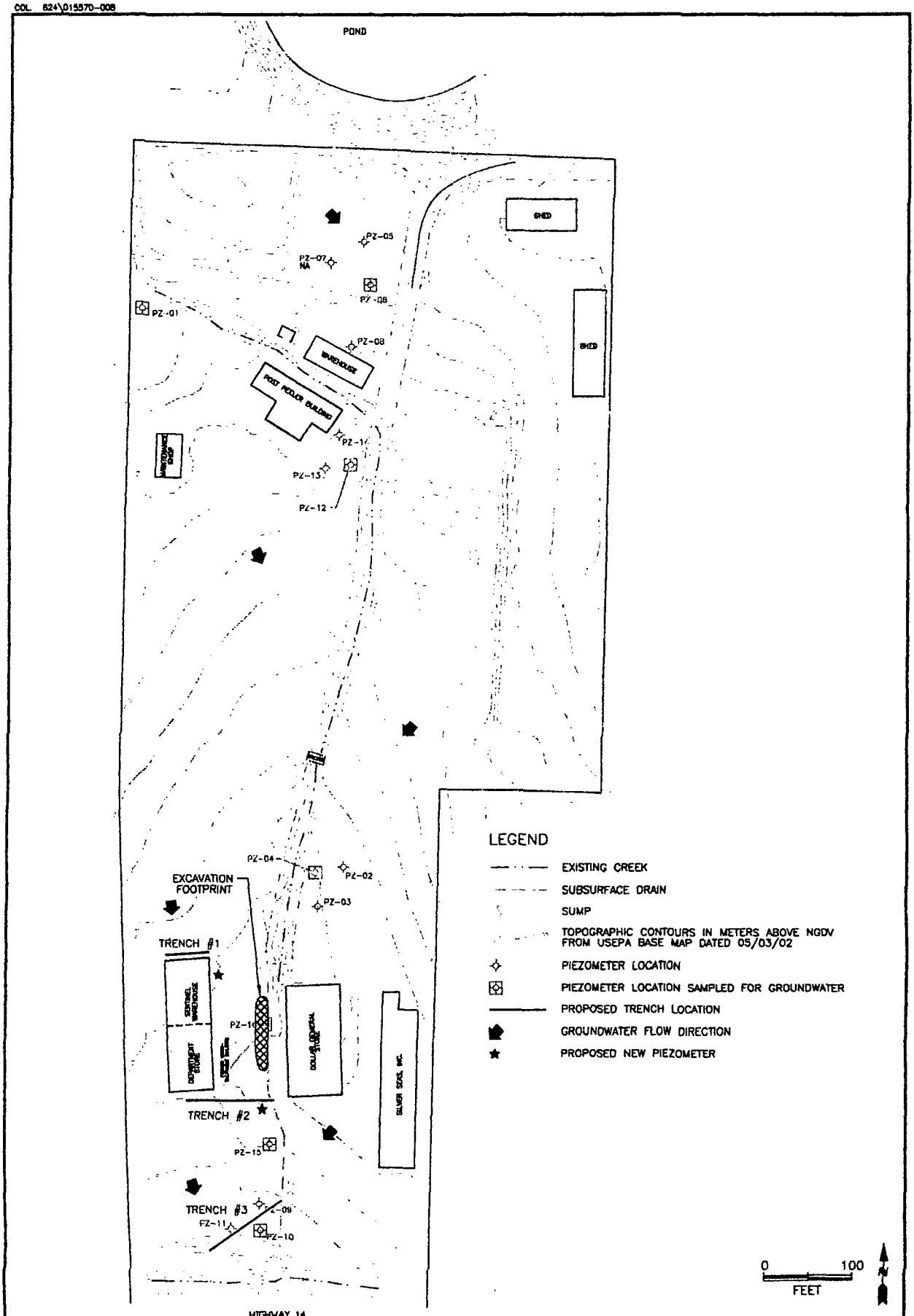
FIGURE 5



	FORMER WOOD TREATMENT AREA ISOPLETHS OF PENTACHLOROPHENOL SOIL CONCENTRATIONS	ORIGIN: RR CHECK: DATE: JULY 04	DESIGN: APPR: REV: 1

PROJECT NO: 62401557
SENTINEL WOOD TREATING
AVA, MISSOURI
FIGURE 6

COL 624\015570-008



PSC

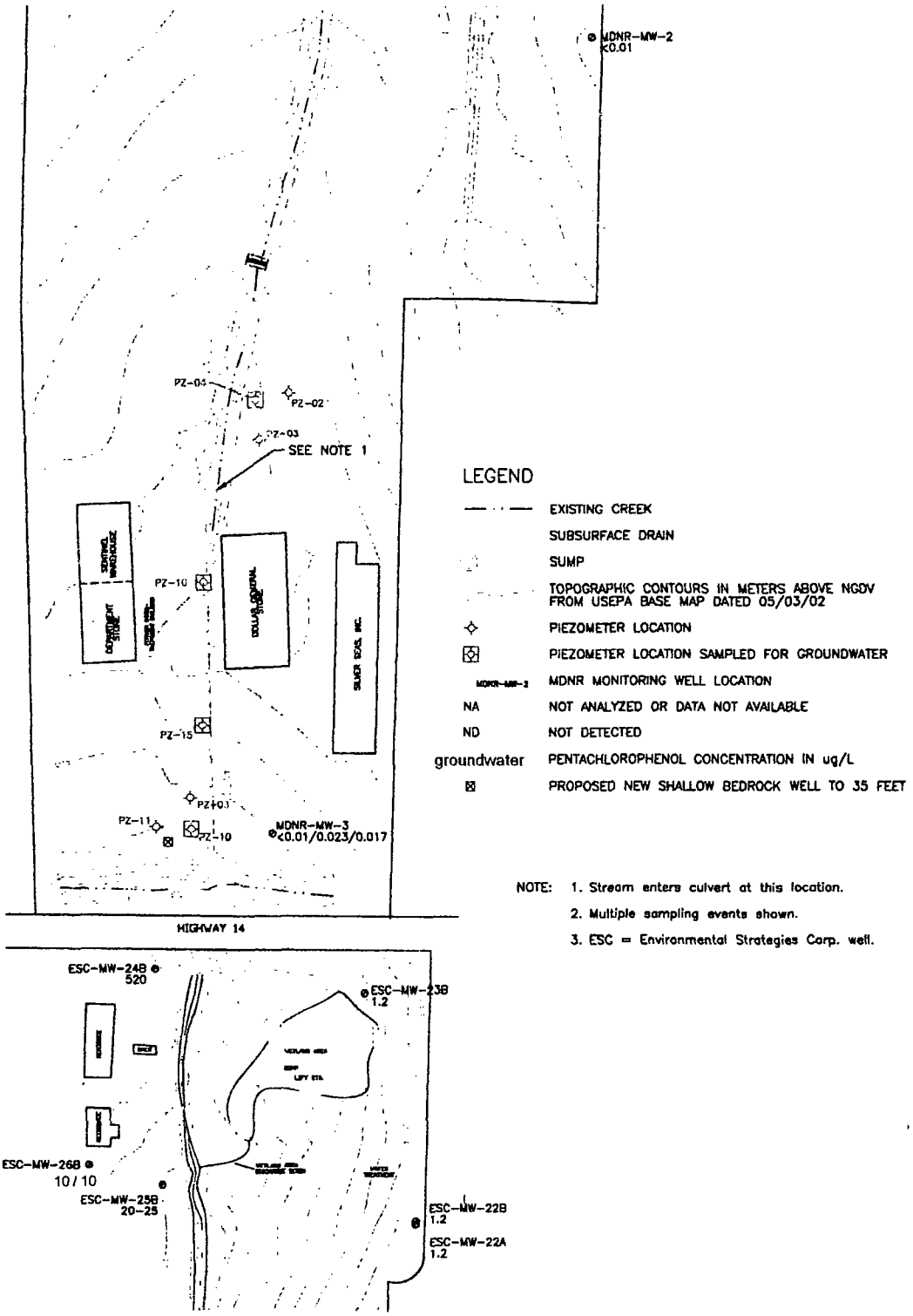
TITLE:
PROPOSED REMEDIATION EXCAVATION AND TRENCH LOCATIONS IN FORMER WOOD TREATMENT AREA

DRN: TMM	DES.: DEM
CHECK:	APPD:
DATE: 10/1/03	REV.: 0

PROJECT NO.: 62401557
SENTINEL WOOD TREATING
AVA, MISSOURI

FIGURE 7

COL 624\01557D-012



PSC

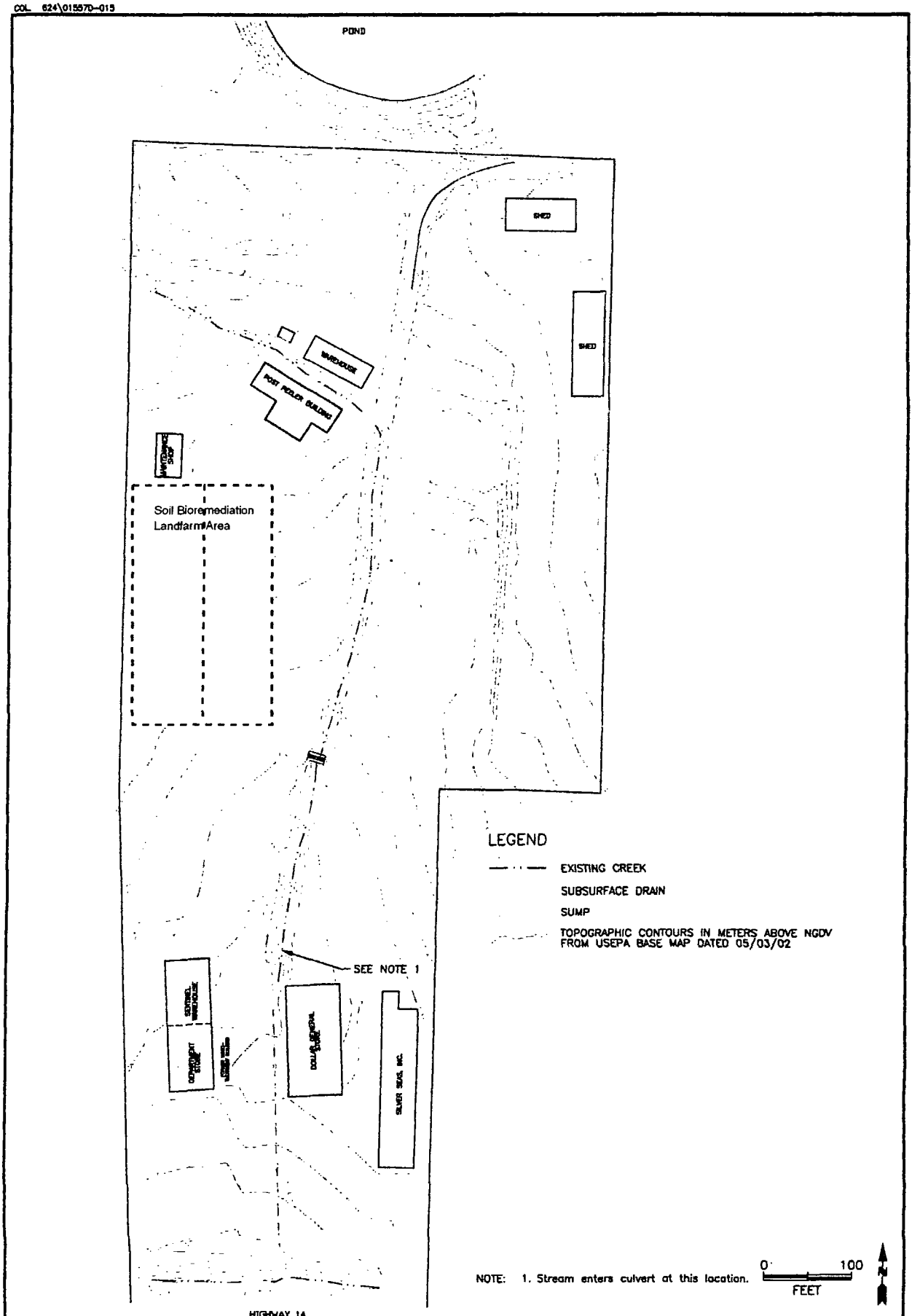
TITLE:
GROUNDWATER PENTACHLOROPHENOL CONCENTRATIONS FOR DOWNGRADIENT WELLS ON MERRITT PROPERTY PARTS PER BILLION

DWN: DES.:
CHKD: APPD:
DATE: 8/23/04 REV.:

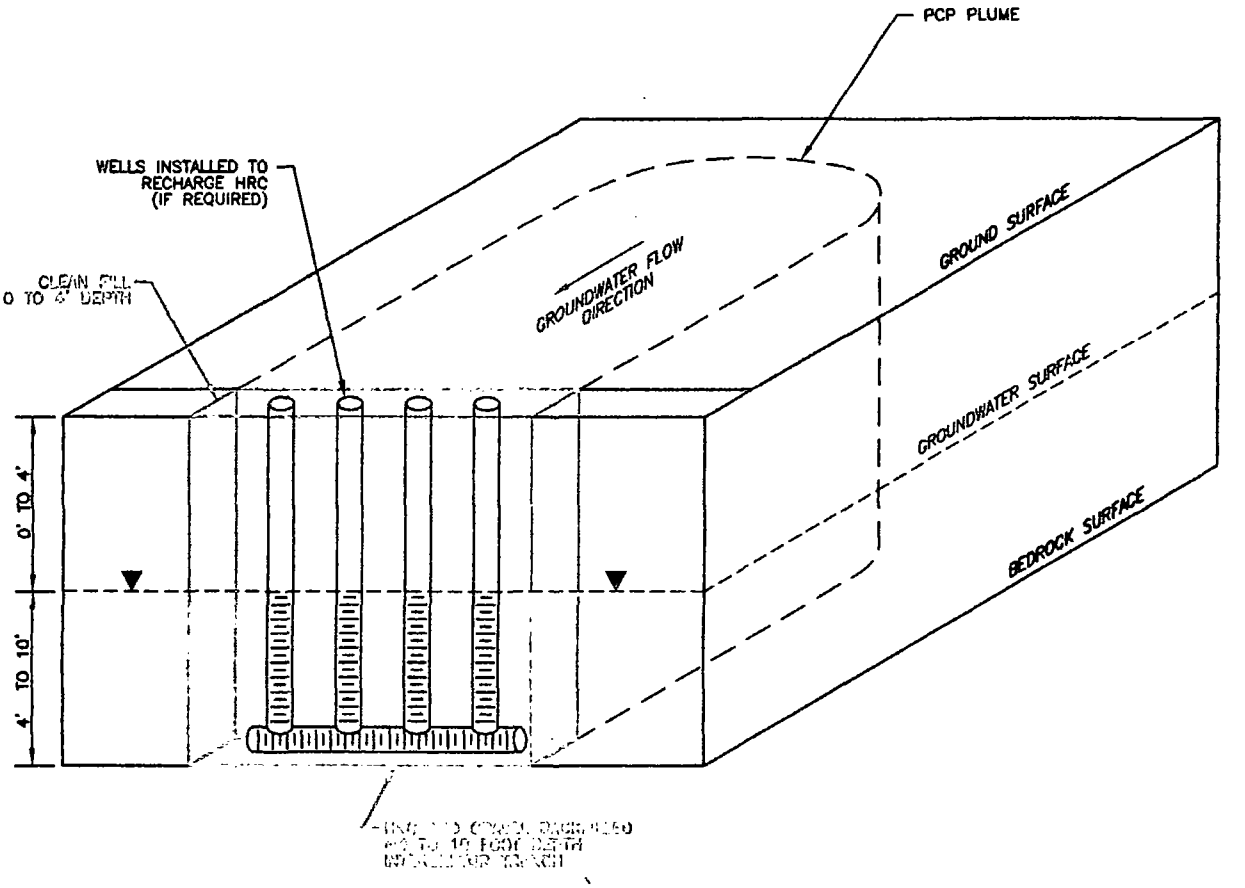
PROJECT NO.: 62401557
SENTINEL WOOD TREATING
AVA, MISSOURI

FIGURE 8

COL. 624\015570-015

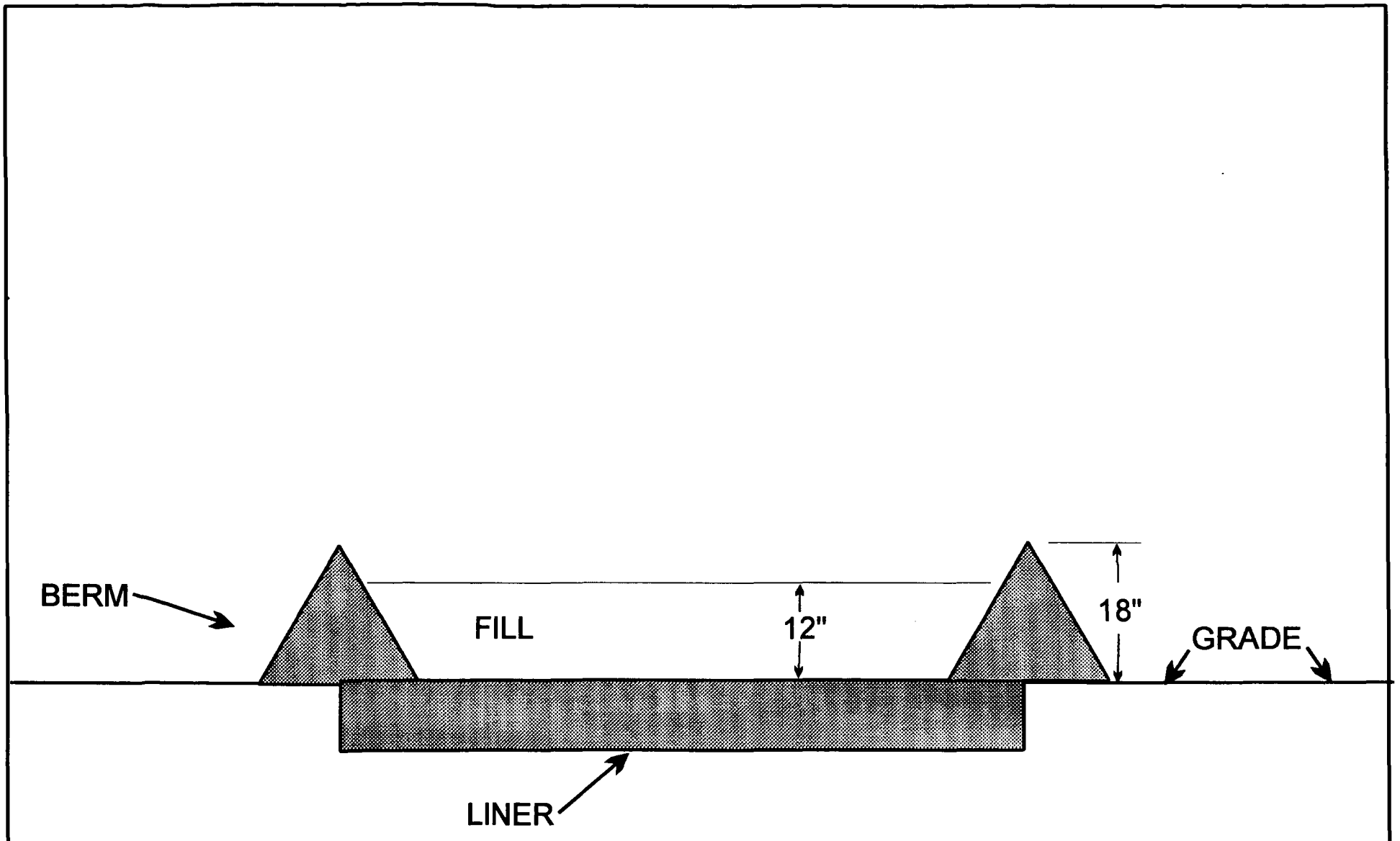


TITLE: PROPOSED BIOREMEDIATION SITE CONSTRUCTION	DRWN: RR	DES.:	PROJECT NO.: 62401557
	CHKD:	APPD:	SENTINEL WOOD TREATING AVA, MISSOURI
	DATE: 7-31-04	REV.: 1	FIGURE 9



PSC	TITLE: SCHEMATIC OF HRC TREATMENT BARRIER	DWN: TMM	DES.: DEM	PROJECT NO.: 62401557	SENTINEL WOOD TREATING AVA, MISSOURI
		CHKD:	APPD:		FIGURE 10
		DATE: 9/30/03	REV.: 0		

COL 624\01557E-001

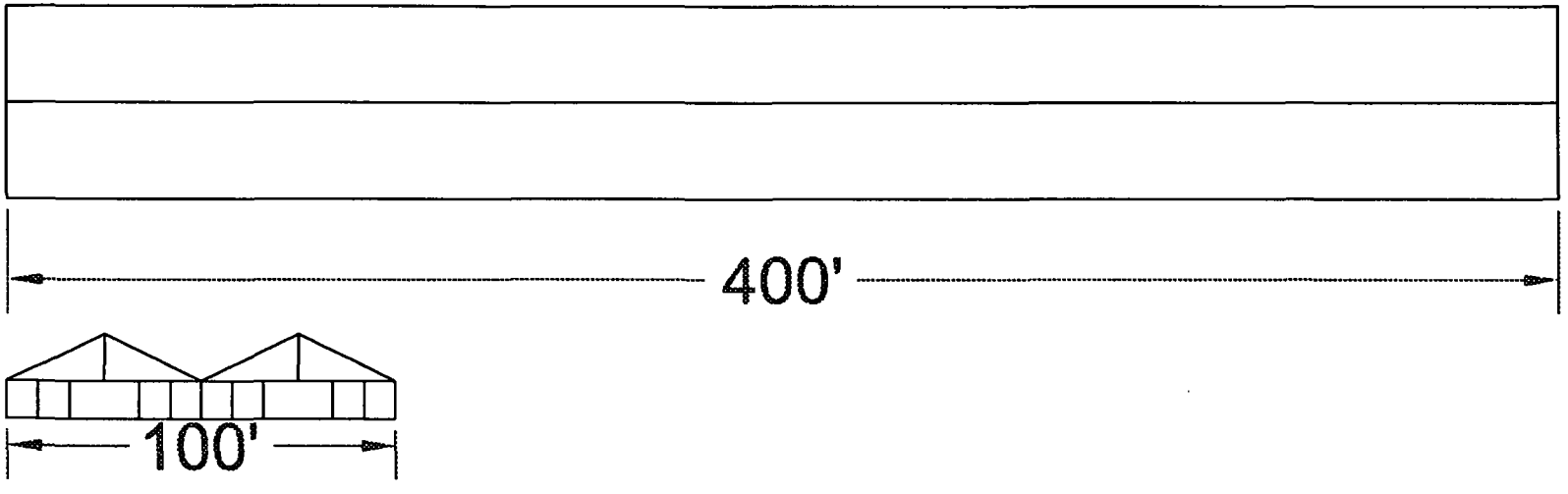


BERM & LINER ARE OF THE SAME CLAY BENTONITE MIXTURE

CROSS SECTION OF BIOTREATMENT PAD
FIGURE 11

NO SCALE

BIOREMEDIATION TREATMENT CELL FIGURE 12



8-20-04

SENTINEL WOOD TREATING SITE
Ava, Missouri

QUALITY ASSURANCE PROJECT PLAN (QAPP)

ADDENDUM

FOR
REMEDIATION WORK PLAN

REVISED August 20, 2004

Prepared by:
LAFSER & ASSOCIATES, INC.
ST. LOUIS, MISSOURI

1 PROJECT MANAGEMENT

1.1 QUALITY ASSURANCE PROJECT PLAN ADDENDUM FOR THE SENTINEL WOOD TREATING SITE, AVA, MISSOURI

1.2 APPROVALS

L&A Project Manager Fred Lafser

(Signature and date)

L&A QA Manager Roger Riemann

(Signature and date)

U.S. Environmental Protection Agency (USEPA) Removal Project Manager Eric Nold

(Signature and date)

U.S. Environmental Protection Agency (USEPA) QA Manager

(Signature and date)

1.3 TABLE OF CONTENTS

1.4 DISTRIBUTION LIST

EPA-Region VII	Eric Nold
Sentinel Wood Treating	Don Farris
Lafser & Associates, Inc.	Roger Riemann/Bryan Hart
Philip Environmental Services	Dale Markley
Subcontractors	TBD

1.5 PROJECT/TASK ORGANIZATION

Fred A. Lafser, President of Lafser & Associates, Inc. (L&A) will serve as project manager (PM) for the activities described in this Addendum to the Quality Assurance Project Plan (QAPP), which is to be implemented at The Sentinel Wood Treating Site, Ava, Missouri. The EPA Project Manager is to provide review and comment on plans and reports submitted to EPA by Sentinel Wood Treating Site and to ensure that the Company complies with and meets the requirements listed in the plan. The role of the EPA Quality Assurance Manager (QAM) is to review the QAPP and any subsequent revisions in terms of quality assurance aspects. Roger Riemann will be responsible for overall coordination of site activities, ensuring implementation of the QAPP sampling, and providing periodic updates to Environmental Protection Agency (EPA) concerning the status of the project, as necessary. Mr. Riemann will be responsible for acquisition of necessary sampling equipment, split sample collection, field documentation and submittal of samples to the laboratory, and preparation of summary reports. Brian Hart, Site Manager for Lafser & Associates, Inc. will serve as Field Coordinator. Philip Environmental Services Corporation will provide geological engineering services, and geologic interpretation. Mr. Dale Markley will be the Philip subcontract manager.

1.6 PROBLEM DEFINITION/BACKGROUND

Introduction

This introduction is relevant to Section 1.3 Problem Definition / Background, of the previously approved March 5, 2002 Quality Assurance Project Plan (QAPP). This addendum addresses items to be incorporated into the QAPP with relationship to the Remediation Action Work Plan's (RAWP) Compliance Sampling, Bioremediation Treatment Cell development and operation and the In-Situ Bioremediation activities.

All items listed within this document will be introduced by correlating the text to the appropriate section as listed in the previously approved QAPP. The following text should be considered as additional information to aid the QAPP regarding the addition of the RAWP. Therefore, only the corresponding QAPP sections listed

below should be considered as necessary information to be included. Likewise, not all sections of the QAPP have been addressed below, if the need was not pertinent to the addition of the RAWP.

The cleanup levels for Pentachlorophenol (PCP) at the site are based on draft action levels of 11 parts per million (ppm), 30 ppm and 110 ppm for land use, 1 part per billion (ppb) ground water and Dioxin Equivalents of 1, 5, and 20 ppb for soils. Clearance sampling of excavation areas and biologically treated soils, and ground water monitoring to meet the cleanup levels above are the goals of the of the RAWP. Surface waters and ground water goals are < 1 ppb. The industrial/commercial use level of 30 ppm will be the clearance goal of contaminated soil excavation areas and soils undergoing treatment. Institutional controls will be used to restrict future use to commercial/industrial. With EPA approval, the 110 ppm PCP level may be used for soils remaining on site under barriers if other remedies are not successful.

1.7 PROJECT/TASK DESCRIPTION

The various tasks to be accomplished by this RAWP are as follows:

- The construction of a 40,000 sq ft lined, covered bioremediation treatment cell on the west side of the creek
- The installation of 3 passive trench barriers for the introduction of HRC for in-situ anaerobic treatment of ground water and smear zones
- Excavation and preparation of contaminated soils for incorporation into the bioremediation treatment facility
- Size reduction of lagoon materials
- Compliance sampling in excavated areas
- Point source chemical treatment of PCP contamination
- Closure of those areas meeting cleanup goals
- Monitoring of parameters for the bioremediation treatment facility operation
- Monitoring of ground water parameters for the treatment barrier operation
- Compliance monitoring of the bioremediation treatment cell facility soils
- Compliance monitoring of the ground water and surface water

1.8 DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) for the activities performed under this project should ensure that environmental data obtained meet the needs of the operation and can be used with confidence to support specific cleanup decisions pertaining to this site. It is the overall objective to keep the total uncertainty within an acceptable range (±20% for water samples and ±30% for soils) that will not hinder the intended use of the data. The laboratory will run surrogate matrix spikes for each soil and water sample for PCP. Additionally they will run surrogate spikes, duplicate water and soil samples for PCP. Sampling procedures will follow EPA methods

The DQO process is a strategic planning approach based on scientific methods that has been used to prepare for this data collection program. It provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when and where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect. The DQOs have been used to develop a scientific and resource effective data collection design. Based on the Agency's direction site soil concentrations for action levels of 11 parts per million (ppm), 30 ppm and 110 ppm for various land uses, 1 part per billion (PPB) ground water and dioxin equivalents of 1, 5, and 20 ppb for soils will be used as starting points to determine remediation goals and assure analytical methods are sufficient to identifying levels of the contaminates of concern. DQOs define the total uncertainty in the data that is acceptable for specific activities conducted during the investigation. The uncertainty includes both sampling error and analytical error. It is the overall objective to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data. The QA/QC requirements have been established such that there will be a high degree of confidence in the measurements.

The DQOs developed for this investigation will generate data of sufficient quality to support both qualitative and quantitative conclusions concerning the potential sources of contaminants at the site, to support engineering evaluations of potential remedial response activities, and to support the risk assessment. In order to achieve these DQOs, the process of data generation was designed to support conclusions made as a result of this investigation. Specific data quality requirements such as criteria for precision, accuracy, representativeness, completeness, comparability (PARCC), and sensitivity are specified in this document.

In order to assess adherence to DQOs, L&A has developed the QA/QC program described in this QAPP. The USEPA Contract Laboratory Program (CLP) states that the purpose of a QA/QC program is: "The definition of procedures for the evaluation and documentation of sampling and analytical methodologies and the reduction and reporting of data. The objective is to provide a uniform basis for sample collection and handling, instrument and methods maintenance, performance evaluation, and analytical data gathering and reporting." This QAPP for sampling, analysis, and data handling is consistent with the requirements set forth by the USEPA.

1.8.1 Definition of Measurement Criteria

Quality assurance parameters including precision, accuracy, representativeness, comparability, completeness, and sensitivity will be used in the assessment of data quality. These parameters are described below.

1.8.1.1 Precision.

Precision describes the reproducibility of results. It is defined as the agreement between the numerical values of two or more measurements that have been made in an identical manner. Precision can be expressed in a variety of manners, including absolute methods such as deviation from the mean or median values, standard deviation and variance, or relative methods, such as relative deviation from the mean or median. Precision will be expressed as relative percent difference (RPD) and percent relative standard deviations (%RSD) in accordance with method requirements. Precision will be evaluated through the analysis of field and laboratory duplicate samples and spiked samples (MS/MSDs). The initial calibration %RSD is actually a measure of the precision of the analytical process over the calibration range of interest. Therefore, precision will also be monitored through the %RSDs generated during initial calibration. Surrogate matrix spikes will be ran for each PCP soil and water sample submitted to the laboratory.

1.8.1.2 Accuracy

Accuracy is a measure of closeness of an individual measurement or average of a number of measurements to the true value, and is expressed in terms of absolute or relative error. Accuracy will be expressed as percent recoveries (%R) or percent differences (%D) in accordance with method requirements. Accuracy will be evaluated through the analysis of spiked samples which include laboratory control samples (LCSs), matrix spike (MS) samples, surrogate spikes and the analysis of standards with known concentrations (calibration and calibration verification standards). Surrogate recoveries are designed to provide information about the affect of sample preparation and matrix bias. Samples are spiked in the laboratory with surrogate compounds prior to sample preparation. The evaluation of the results of the surrogate spikes is not necessarily straightforward. The sample itself may produce effects due to such factors as interference and high concentrations of analytes. The MS sample analysis is designed to provide information about the effect of sample preparation and analysis methodologies with regard to sample matrix affects. The LCS sample analysis is designed to provide information about the affect of sample preparation and analysis methodologies with regard to analytic instrumentation. LCS recoveries also provide an independent verification on the calibration procedure and the percent recovery of the calibration standards provides a measure of accuracy.

1.8.1.3 Representativeness

Representativeness refers to the relationship of the sample taken from a site to be analyzed to the sample matrix at the site. Representativeness will be maximized by the careful selection of sampling locations and the use of USEPA

procedures for the collection and preservation of samples as described in the Work Plan.

1.8.1.4 Comparability

Comparability refers to the use of consistent procedures, second source reference standards, reporting units, and standardized data format with document control and data validation. Adherence to standard procedures and the analysis of external source standard materials maximizes the probability that data generated at a given laboratory can be validly compared to the data of another. In addition, the analytical laboratory participates in a number of external certification programs, and is evaluated through the analysis of performance evaluation samples.

1.8.1.5 Completeness

Completeness refers to the process of obtaining required data as outlined in the Work Plan. Completeness is defined as the percentage of measurements judged to be valid relative to the number of samples submitted for analysis. The completeness goal has been specified at 90% for this investigation. Since the scope of work for this investigation will be modified from time to time based on newly collected data, the number of samples planned for collection will be tracked. The data validation report will present those samples submitted for analysis and a determination of the percentage of complete measurements. Data completeness will be calculated to include all methods and matrices as follows: We believe all samples should be able to be collected. The only samples which leave question are the ground water sample which from previous sampling excisions may or may not produce sufficient water for analysis. Surrogate matrix spikes are ran with each sample submitted for PCP analysis. The analytical methods selected are sufficient to meet monitoring levels of interest. Baring loss in the laboratory we feel a 90% completeness is achievable. % Completeness = (Number of Usable Analytical Results x 100)/Total Number of Submitted Analytical Data

1.8.1.6 Sensitivity

Sensitivity refers to a measurable concentration of an analyte, which has an acceptable level of confidence. Method detection limits (MDLs) are the lowest concentration of an analyte that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDLs derived from reliable analyses of spiking analyte-free water with a known amount of analyte and positively identifying and quantifying the analytes. Practical Quantitation Limits (PQLs) or Reporting Limits (RL) are experimentally established quantitation limits. PQLs are levels above the MDLs at which the laboratory can demonstrate accuracy and precision measurements within the laboratories control limits. PQLs have been determined through spiking analyte-free water and

evaluating the percent recovery of the standards and are usually relative to the MDLs. MDLs are established utilizing procedures outlined in 40 CFR 136 Appendix B (Federal Register, October 26, 1984) and in the appropriate analytical methods. MDLs and PQLs are established in order to demonstrate the level of sensitivity of the analytical methods. MDLs and PQLs will vary through time. The MDLs are adjusted accordingly based on periodical MDL studies. The PQLs are relative to the comment MDLs and as the MDLs change, the PQLs values will change. A decision to collect additional samples due to any invalidated data will be made by the L&A Project Manager and the EPA Project Manager after the validated data are reviewed. Field precision, as determined by the collection and statistical analysis of duplicate samples, will be evaluated for this project, because an evaluation of spatial variability of the contaminants will be required for appropriate decisions defining the extent of contamination used to delineate any additional areas of contamination. To ensure completeness of the sample data, each datum will be recorded on a site map. As described earlier, all samples for PCP will be run with surrogate matrix spikes by the laboratory. The minimum detection levels MDL for the methods to be used are from SW-846. PCP 8151 and Dioxin 8290. (PCP MDL's are .076 ppb aqueous and .16 ppb soil) (Dioxin MDL's are 10 ppq aqueous and 1ppt soil).

1.9 SPECIAL TRAINING/CERTIFICATION

The only formal training required of site personnel will be the completion of a basic 40-hour (Hazardous Waste Operations and Emergency Response [HAZWOPER])
8 Hour Refresher Certificate (Current - i.e., within last 12 months)
HAZWOPER 8 Hour Supervisor Certificate (If applicable)
Familiarization with sampling equipment/procedures will also be necessary for the sampling team.
Confined Space entry (trenches and culvert) will be contracted to qualified firms with properly trained workers.

1.10 DOCUMENTATION AND RECORDS

L&A personnel and/or subcontractors will maintain a field logbook to record all pertinent activities associated with the operation and sampling events at the site. Information pertaining to soil samples (i.e., sampling dates/times, location, etc.) collected during this event will be recorded on field sheets. Labels identifying sample number, dates collected, and requested analyses will be affixed to sample containers. Field sheets and labels will be generated and provided by L&A personnel.

During the project, the field logbooks, records, and reports should be maintained on-site for the duration of the project and will be included in the reports to the EPA. Copies may be maintained at the L&A office. Upon completion of the project, all logbooks, records, and reports should be maintained at the L&A office. Project records and reports will be kept at the L&A office for a period or 2 years. Laboratory results, quality control samples and chain of custody records are

included in the data package from the laboratory. The Project Manager is responsible for ensuring the most current, approved version of the QAPP is available. Any updates will be made to the distribution list and identified as revisions. Difficulties or issues encountered in the field will be noted in the field logbook. Laboratory issues are discussed by the laboratory manager in the cover letter accompanying the report.

2 DATA GENERATION AND ACQUISTION ELEMENTS

2.1 SAMPLING PROCESS DESIGN

Sampling will occur to provide a check:

- On the operational parameters necessary to monitor the condition of the soil in the bioremediation treatment cell for optimum pH, oxygen, moisture, and nutrients
- Monitoring the degradation of the PCP in the bioremediation treatment cell through quarterly sampling
- Clearance samples of PCP, and Dioxin in excavations and from treated materials
- Water samples for HRC activity for the in-situ anaerobic treatment and PCP ground water reductions
- Treatment parameters for the carbon filter
- Surface water samples for monitoring remediation efforts.

Table 1 "SAMPLE LOCATIONS/QUANTITY/ANALYTES", provides the number of samples, frequency, location, and analytes to be monitored.

Table 1 SAMPLE LOCATIONS/QUANTITY/ANALYTES

TABLE 1 SAMPLING SCHEDULE 8-25-04				
Sample type/ location/frequency	**Other**	**Dioxin**	**PCP**	**HRC***
GROUNDWATER				
Trench Monitoring				
Quarterly				
PZ-9			1	1
PZ-10			1	1
PZ-11			1	1
PZ-15			1	1
PZ-17 NEW PIEZO			1	1
PZ-18 NEW PIEZO			1	1
QA/QC			1	1
Total per quarter		0	7	7
Total per year		0	28	28
Site well Monitoring				
Quarterly				
ESC-MW-24			1	
ESC-MW-25			1	
ESC-MW-26			1	
MW- 4 NEW WELL			1	
MNDR-MW-3			1	
MNDR-MW-1 Q/C			1	
PZ-1 Q/C			1	
PZ-4			1	
PZ-6			1	
PZ-8			1	
PZ-12			1	
Total per quarter		0	11	0
Total per year		0	44	0
SURFACE WATER				
Quarterly				
SW-3 Q/C			1	
SW-4			1	
SW-5.5			1	
Total per quarter			3	
Total per year		0	12	0
BIOREMEDIATION SOILS				
2-4 wks				
Moisture, pH				
Monthly May-October				
1 Composite of 8 aliquots for each 5,000 sq. ft. section			8	
Total per seasonal year		0	48	0
Annually				
1 Composite of 8 aliquots for each section for Oxygen, Nitrogen, Phosphorus, and Potassium per 5,000 sq. ft.	8			
Total per Year	8			
Clearance Per 2 year Batch Cycle				
1 Composite of 8 aliquots for each 10,000 sq. ft. section		4		
Allowance for Retest			16	
Total per treatment batch cycle		4	16	
TREATMENT CELL WATER				
Quarterly				
Sump if water present			4	
Total per year			16	
ADDITIONAL LAGOON CHARACTERIZATION		4	20	
EXCAVATION CLEARANCE BOUNDARY SOILS				
3 Composites of 6 aliquots for each of five excavations		15	15	
Retest		5	15	
QC Duplicate		3	5	
Total		23	35	
WATER TREATMENT ACTIVATED CARBON				
Monthly				
Influent			1	
Effluent				
Monthly - pH, temp, PCP	1		1	
Annually - Wet Test	1			
Primary Activated Carbon Cell Discharge			1	
Total per year (8 Months)	9		17	
WELL INSTALLATION SOILS				
PZ-17 3 levels one time			3	
PZ-18 3 levels one time			3	
Total first year			6	
CONTINGENCY SAMPLES	10	2	20	4

*note (HRC) Hydrogen Release Compound Analytes
Organic Carbon, Mn, Fe, Cl, TOC, Alkalinity

2.2 SAMPLING METHODS

Excavation activities are proposed for the former treatment plant area, contaminated roadways, and former lagoons. All visible stained soils will be excavated from the areas and distributed in the bioremediation treatment cell. Excavated areas will be sampled by taking random aliquots and compositing as an extended surface sample (0-6 inches). One aliquot will be collected from each 1000 sq ft of surface area exposed by excavation. One sample will be collected for each 5000 sq ft of surface exposed by excavation. The sample will be homogenized and split into four quarters. One sample will be sent to the laboratory for testing and one sample split will be provided to EPA. The others will be back-up samples and will be introduced into the bioremediation treatment cell.

If the test indicates contamination above the established project cleanup goals, the excavation with placement of material into the bioremediation treatment cell will be continued and the sampling process repeated. This will continue until the project cleanup goal is achieved.

Well sampling will be done primarily by use of disposable, well-dedicated tubing and a peristaltic pump.

Soil pH, and Moisture by Kelway soil Acidity and Moisture Tester (Model HB-20) or equivalent. Moisture should be maintained at 60-80% saturation, pH of 6.5-8, and oxygen >5%. Nutrients of nitrogen 250-300 mg N/kg and phosphate 25-50 mg P/kg are ideal conditions. Nutrient levels will also be monitored and adjusted as needed. On a monthly basis, the contaminated media will be aerated by plowing and tilling.

Sampling the Bioremediation treatment cell will be by core sampler at a depth of 12 inches. The bioremediation treatment cell area will have two 50 x 400 covered sections. The bioremediation treatment cell sections will be grid into 25X25 foot plots. A composite sample for each 5,000 $ft.^2$ section will be taken by dividing the section into 8 25X25 foot plots and randomly taking an aliquot from each plot. The aliquots are homogenized into a composite for that section. Pentachlorophenol will be sampled monthly during growing months of May - October and Dioxin equivalents on a per 2 yr. batch cycle. Bioremediation Treatment cell operating parameters will be monitored on a monthly basis. These include moisture, and pH.

Surface water grab samples will be collected by immersing the sample containers directly into the surface water body (pond or creeks) at the probable point of entry of

any contaminant runoff from the site or at the closest linear point to the areas of concern.

2.3 SAMPLE HANDLING AND CUSTODY

All samples will be placed into laboratory provided glass jars. All samples will be packaged and preserved according to the Method per Table 2. Specifically, the samples will be packed into laboratory provided sample coolers with bubble wrap or similar packaging to ensure against breakage. The samples will be preserved as noted in the sampling table. All samples will be preserved by packing the coolers with double-zip-locked baggies of ice or blue ice. Sufficient ice should be used to maintain a cooler temperature of 4°C. All samples should be placed in zip-locked baggies as well, to prevent the samples or their labels from obtaining moisture from condensation or melting ice.

Table 2 Container and Preservation Requirements

WATER			
Parameters	Container (s)/Volume	Preservative (s)	Holding Time
Pentachlorophenol	One 1-liter amber jars	Cool to 4 deg. C	7 days to extract 40 days for analysis
Dioxins	One 1-gallon amber jar	Cool to 4 deg. C	3 0 days to extract 45 for analysis
Total Organic Carb.	Pint-amber glass	H2SO4	28 days holding
Total Mn,Fe	½ pt-plastic	HNO3	6 months
Alkalinity/Chloride	Pint-plastic	Cool to 4 deg. C	2 days
SOILS			
Parameters	Container(s)/Volume	Preservative (s)	Holding Time
Pentachlorophenol	One 9-oz glass jar	Cool to 4 deg. C	30 days to extract 45 days for analysis
Dioxins	One 9-oz glass jar	Cool to 4 deg. C	30 days to extract 45 days for analysis

The chain of custody (COC) will be maintained for the collected samples, from collection to shipment or delivery to the lab. The sampler will complete the COC as samples are collected and will keep the COC with the samples at all times. Once the COC has had all pertinent information completed, the COC will be placed in a zip-locked bag and secured to the inside lid of the sample cooler containing the listed samples. If more than one cooler is needed for the same COC, a photocopy or carbon copy of the COC should be placed in each cooler containing the samples as listed on the COC. A laboratory specific COC may be used.

The samples will be shipped/delivered to the appropriate laboratory based on the analytical method to be tested. A separate COC should be used per the analytical methods requested per each laboratory.

Environmetrics of St. Louis, Missouri has been selected to perform the analyses of PCP and well parameters Elizabeth Ghafoori, Project Manager is responsible

for corrective action in the laboratory. Environmetrics will subcontract Dioxin analysis to Pace Analytical.

2.4 ANALYTICAL METHODS

The analytical methods have been chosen to meet the detection levels to measure both water and soil contamination. The cleanup levels for the site for PCP are based on action levels of 11 parts per million (ppm), 30 ppm and 110 ppm for various land uses, 1 part per billion (PPB) ground water and dioxin equivalents of 1, 5, and 20 ppb for soils.

2.5 QUALITY CONTROL

Quality control samples will be collected as duplicate or split sample with the EPA for the clearance samples. Quality control water samples will be collected at the rate of 10% of total samples. All PCP soils and water samples will be run with a surrogate matrix spike. Final closure will provide split samples with the EPA or duplicate.

2.6 DATA MANAGEMENT

Field logs of sample collection and field data will be maintained in a field log book and field records folder. This information will be used along with summaries of analytical data and provided in monthly reports to the agency's project manager All Laboratory data collection and reduction are governed the selected labs SOP's. Microsoft Office will be used to compile data spreadsheets and reports.

Site Sampling Plan for Reclamation Addendum

The Sentinel Wood Treating Site

Ava, Missouri

September 30, 2003

Revised August 20, 2004

Prepared for:

SENTINEL INDUSTRIES, INC.

BY:

LAFSER & ASSOCIATES, INC.

638 Chamblee Ln.

St. Louis, Missouri 63141

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PURPOSE

This plan is an addendum of the Site Sampling Plan submitted to the EPA, March 10, 2002. The additions to the plan include monitor the Oxygen Release Compound (ORC) assistance in aerobic biodegradation of Pentachlorophenol (PCP) in the proposed bioremediation treatment cell and to monitor the PCP in the groundwater beneath the property's south parking lot after the use of the Hydrogen Release Compound for anaerobic bacteria stimulation. Excavation areas of the lagoons and roads will be sampled to verify cleanup goals of PCP. Groundwater wells will be sampled to monitor groundwater treatment activity and results. The groundwater carbon treatment plant activities and any permit requirements will be monitored along with the discharge of PCP concentrations. Additionally, we will monitor the creek as it exits the property and down stream to verify cleanup levels for PCP.

1 INTRODUCTION

On September 11, 2001, Sentinel Industries, Inc. (Sentinel), the EPA and MO DNR voluntarily entered into an Administrative Order on Consent (Order) in connection with the Sentinel Wood Treating Site (Site), located in Ava, MO. The Order required Sentinel to submit a Work Plan and Sampling Plan to EPA outlining plans and procedures to reduce or eliminate PCP contamination, which is currently migrating off-site, and to further characterize the site. The scope of this sampling plan is to address the removal and treatment of the contaminated soils which were identified during the site characterization phase of the project, the in-situ treatment of contaminated soils and groundwater, the collection and treatment of groundwater, monitoring of surface water in the creek, and the bioremediation of soils.

2 SITE LOCATION

The Sentinel Wood Treating site is located at 412 NW 12th Street in Ava, Douglas County, Missouri. The legal description is the *W % NE % NW %* sec. *11, T. 26 N., R. 16 W. as noted on* the Ava, Missouri Quadrangle 7.5 Minute Topographic map. The geographic coordinates are Latitude +36.9655, Longitude -92.6601. The site is approximately '/2 mile east of the junction of Highways 14 and 5, on the north side of NW 12th Avenue.

3 DESCRIPTION OF THE SITE[1]

The description and history of this site has previously been covered in the Removal Assessment Work Plan, March 10, 2002.

[1] Work Plan, Sentinel Wood Treating Site, Ava, MO, Site Sampling Plan, March 10, 2002

4 HISTORY/CONTAMINANTS OF CONCERN REFERENCE 1

The description and history of this site has previously been covered in the Removal Assessment Work Plan, March 10, 2002.

5 FIELD ACTIVITIES

Sampling locations have been chosen to monitor the stream's water quality, on-site ground water quality, cleanup boundaries' concentration after contaminated soil removal, bioremediation treatment cell PCP soil concentration reductions, treatment plant discharge, and reduction of PCP. The designated sampling wells and surface water sampling locations are detailed and listed in Table 1 "Sampling Locations/Quantity/Analytes". These locations are shown in Figure 1, Groundwater Pentachlorophenol Concentrations, and Figure 2, Surface Water Pentachlorophenol Concentrations.

5.1 Sampling Methods

All aspects of sampling shall be performed using approved methods for the collection, preservation, and transport of the various media sampled. Modifications to the sampling methods may be made in the field based upon conditions encountered. Any modifications to the methods will be noted in the field logbook and final sampling report submitted to the EPA.

5.1.1 Soil Sampling

5.1.1.1 Bioremediation Areas

Excavation activities are proposed for the former treatment plant area, contaminated roadways, and former lagoons. All visible stained soils will be excavated from the areas and distributed in the bioremediation treatment cell. Excavated areas will be sampled by taking random aliquots and compositing as an extended surface sample (0-6 inches). One aliquot will be collected from each 1000 sq ft of surface area exposed by excavation. One sample will be collected from each 5000 sq ft of surface exposed by excavation. The sample will be homogenized and split into four quarters. One sample will be sent to the laboratory for testing and one sample split will be provided to EPA. The others will be back-up samples and will be introduced into the bioremediation treatment cell.

If the test indicates contamination above the established project cleanup goals, the excavation with placement of material into the bioremediation treatment cell will be continued and the sampling process repeated. This will continue until the project cleanup goal is achieved.

5.1.1.2 Bioremediation treatment cell

Sampling the Bioremediation treatment cell will be by core sampler at a depth of 12 inches. The bioremediation treatment cell area will be 100 x 400 ft . The bioremediation treatment cell will be divided into sections of 50 X 100 ft. These sections will be grid into 25 X 25 foot plots. A composite sample for each 5,000 $ft.^2$ section will be taken by dividing the section into 8 - 25 X 25 foot plots and randomly collecting an aliquot from each plot. The aliquots are homogenized into a composite for that section. Pentachlorophenol will be sampled monthly during growing months of May - October and Dioxin equivalents on a per 2 yr. batch cycle. Bioremediation Treatment cell operating parameters will be monitored on a monthly basis. These include moisture, and pH.

5.1.2 Water Sampling

Field instruments to be used during water sample collection, including pH, specific conductivity, temperature, dissolved oxygen, and turbidity meters, will be calibrated on-site per each unit's manufacturer specifications.

5.1.2.1 Surface Water

Surface water grab samples will be collected by immersing the sample containers directly into the surface water body (pond or creeks) at the probable point of entry of any contaminant runoff from the site or at the closest linear point to the areas of concern. Surface water sample locations will be SW-4 and SW-5.5 shown on Figure 2. If required to enter water, personnel will approach the sampling location from downstream to minimize sediment disturbance during collection. Samples will be analyzed according to Table 1.

5.1.2.2 Ground Water

Sampling will be done primarily by use of disposable, well-dedicated tubing and a peristaltic pump. As an option, samples may be collected using a mini-bailer with a check valve. Samples will be collected following the U.S. Environmental Protection Agency (USEPA) protocol, *Low Flow (Minimal Discharge) Groundwater Sampling Procedures* (April 1996). Parameter stabilization will be used as the basis for when to collect a water sample. If the wells produce insufficient volume to use the protocol, then a sample will be collected when the well recharges adequately to collect a sample. Purged water will be collected and run through the carbon treatment system. The field notes will document the site conditions observed. Parameters monitored during purging using field instruments will include pH,

temperature, turbidity, conductivity, and dissolved oxygen. Sample locations are shown on Figure 1. These samples will be analyzed according to Table 1. Additional field notes will include measurement of static water levels, well depth, and riser stickup, and amount of water purged prior to sampling.

5.2 Sampling Order

Personnel will generally attempt to collect samples in the order from least-to-most contaminated areas, based upon site information. Efforts will be made to collect background samples prior to any on-site and/or target samples. Containers for each sample will be filled based upon the volatility of the analytes of concern and the most volatile analytes will be collected first. In the event sediment and surface water samples are collected at, or near, the same point, personnel will collect surface water grabs prior to the corresponding sediment grabs to minimize turbidity.

5.3 Sample Quantity

Refer to Table 1 for the approximate number and locations of samples to be collected (subject to change based upon field conditions and observations).

5.4 Analyses Requested

Based on the history of the site and previous sampling conducted, samples will be analyzed for PCP and Dioxin. Other samples are necessary for operation of the carbon treatment facility, bioremediation treatment cell, and HRC activity and are detailed on Table 1.

5.5 Sample Container and Preservation Requirements

Refer to the following tables for container and preservation requirements on all samples.

Water Samples

Parameters	Container (s)/Volume	Preservative (s)	Holding Time
Pentachlorophenol	One 1-liter amber jars	Cool to 4 deg. C	7 days to extract 40 days for analysis
Dioxins	One 1-gallon amber jar	Cool to 4 deg. C	3 0 days to extract 45 for analysis
Total Organic Carbon.	Pint-amber glass	H2SO4	28 days holding
Total Mn, Fe	½ pt-plastic	HNO3	6 months
Alkalinity/Chloride	Pint-plastic	Cool to 4 deg. C	2 days

Soil Samples

Parameters	Container(s)/Volume	Preservative (s)	Holding Time
Pentachlorophenol	One 9-oz glass jar	Cool to 4 deg. C	30 days to extract 45 days for analysis
Dioxins	One 9-oz glass jar	Cool to 4 deg. C	30 days to extract 45 days for analysis

5.6 Chain-of-Custody

All samples will receive a numbered label and the corresponding number entered onto a chain-of-custody form indicating the description, location, date and time of collection, and analytes requested. Samples will be stored and transported on ice in coolers. Field personnel or a courier will maintain custody of the samples until relinquishing them to a sample custodian at the approved project laboratory.

6 DATA QUALITY

6.1 Data Quality

To help ensure precise, accurate, representative, complete, and comparable data are achieved, all fieldwork and analyses will be conducted in accordance with the Quality Assurance Project Plan for the site.

6.2 Field Methods

Clean disposable nitrile gloves will be worn by sampling personnel and clean or field decontaminated equipment will be utilized for each separate sample collected to minimize the possibility of cross-contamination.
Field personnel shall note all observations, sample locations, descriptions, and methods in a field logbook.

6.3 Field Decontamination

Field decontamination of sampling equipment, if required, will be accomplished as follows:
Remove gross contamination with steel/nylon brushes and/or paper towels
Nylon brushing with a solution of Aquinox™ (non-phosphate) cleaner
Rinse with tap water
Rinse with distilled or deionized water
Final deionized water rinse

6.4 Quality Assurance/Quality Control (QA/QC) Samples

The following definitions for QA/QC samples routinely included/collected during sampling events are utilized.

6.4.1 DUPLICATE (CO-LOCATED) SAMPLES

Duplicate water samples are used primarily to assess the precision associated with sampling methodology and, to a lesser extent, sample heterogeneity and analytical procedures. Duplicate soil samples are used primarily to determine the variability or heterogeneity of the sampled media. Due to the heterogeneity of soils, caution must be used if attempting to assess precision associated with sampling methodology or analytical procedures.
Personnel routinely collect duplicate water samples at a rate of 10% of the total number of water samples collected. Each duplicate sample will be collected at the same location and time as its true sample, using similar equipment and technique. Each duplicate sample will receive a numbered label, be entered onto the chain-of-custody form, and submitted for the same analyses as its true sample.

6.4.2 PERFORMANCE EVALUATION SAMPLES

If requested by U.S. EPA personnel, performance evaluation samples may be incorporated into samples submitted for analysis. Matrix spikes/matrix spike duplicates (MS/MSD) will be used to check precision and accuracy of a sample analysis regarding matrix interference. These samples will replace replicate (split) soil samples, which may be incorporated into sampling events.

6.4.3 EQUIPMENT RINSATE BLANK SAMPLES

Rinsate samples enable personnel to estimate bias caused by residual contamination of field decontaminated equipment used during sample collection. Rinsate samples consist of flushing distilled water over and/or through sampling equipment after field decontamination has occurred and before reusing the equipment and collecting the rinsate in sample containers.
If field decontaminated equipment is used for sample collection, at least one equipment rinsate blank will be collected to assess the effectiveness of field decontamination efforts. Each rinsate blank will receive a numbered label, be entered onto the chain-of-custody form, and submitted for PCP, and or dioxins, as appropriate.

6.4.4 FIELD BLANK

Field blanks enable personnel to estimate bias caused by contamination introduced from environmental conditions inherent to the site (primarily air pollutants). Field blanks consist of certified contaminant free media (soil and/or water), brought to the site from the laboratory, which are either exposed to the site's environment (via opening the containers) or transferred to sample containers on-site. A field blank is not considered relevant for the contaminates being sampled on site.

7 SITE SAFETY

A safety briefing will be held on-site prior to initiating field activities and field personnel will be required to read and sign the site-specific health and safety plan. Refer to the site safety plan.

8 REPORTING

The analytical results of samples collected will be presented, along with methods of collection and observations, in a formal report to be submitted to the EPA.

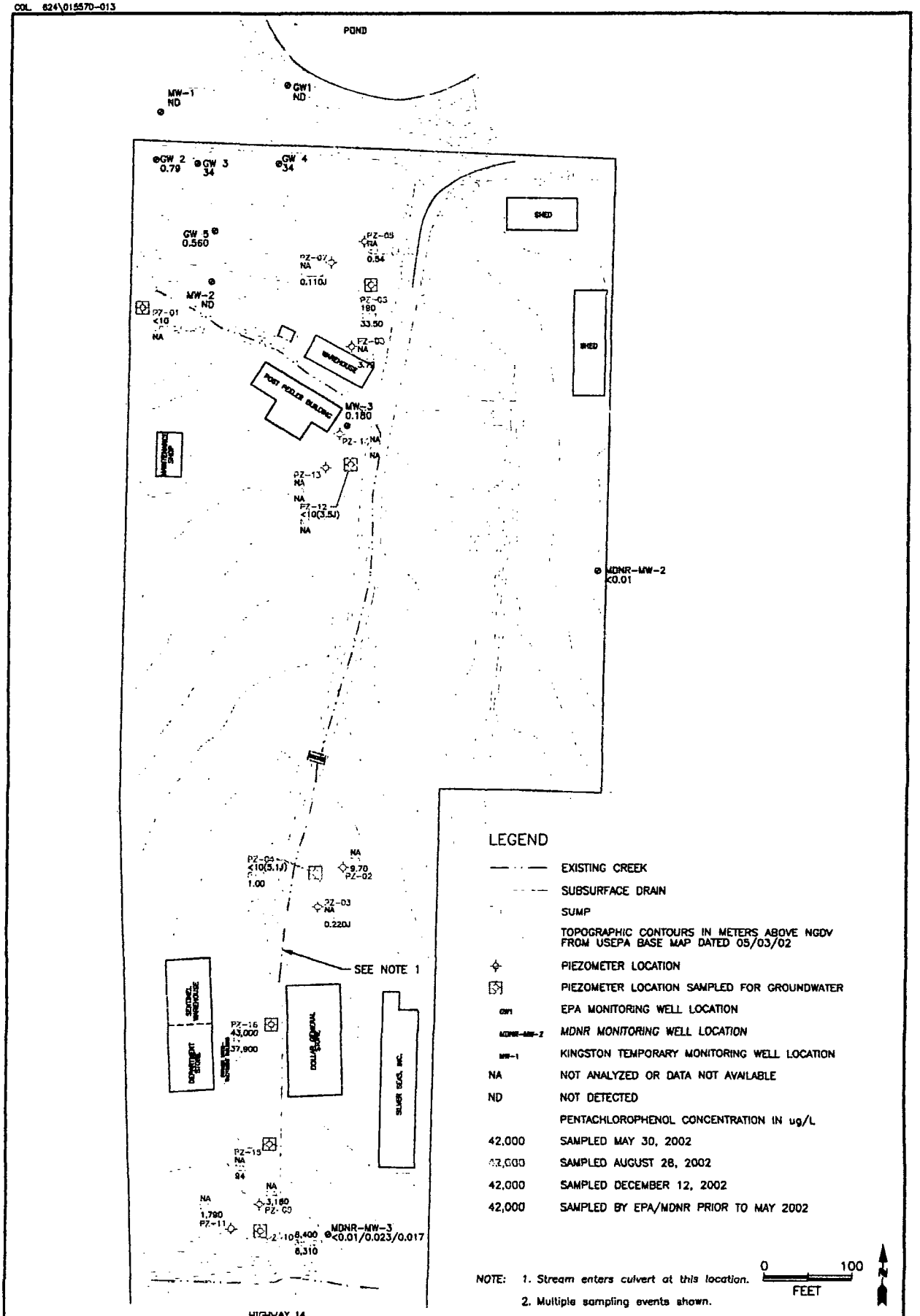
9 TABLE 1. SAMPLE LOCATIONS/QUANTITY/ANALYTES

TABLE 1 SAMPLING SCHEDULE 8-25-04				
Sample type/ location/frequency	**Other**	**Dioxin**	**PCP**	**HRC***
GROUNDWATER				
Trench Monitoring				
Quarterly				
PZ-9			1	1
PZ-10			1	1
PZ-11			1	1
PZ-15			1	1
PZ-17 NEW PIEZO			1	1
PZ-18 NEW PIEZO			1	1
QA/QC			1	1
Total per quarter		0	7	7
Total per year		0	28	28
Site well Monitoring				
Quarterly				
ESC-MW-24			1	
ESC-MW-25			1	
ESC-MW-26			1	
MW- 4 NEW WELL			1	
MNDR-MW-3			1	
MNDR-MW-1 Q/C			1	
PZ-1 Q/C			1	
PZ-4			1	
PZ-6			1	
PZ-8			1	
PZ-12			1	
Total per quarter		0	11	0
Total per year		0	44	0
SURFACE WATER				
Quarterly				
SW-3 Q/C			1	
SW-4			1	
SW-5.5			1	
Total per quarter			3	
Total per year		0	12	0
BIOREMEDIATION SOILS				
2-4 wks				
Moisture, pH				
Monthly May-October				
1 Composite of 8 aliquots for each 5,000 sq. ft. section			8	
Total per seasonal year		0	48	0
Annually				
1 Composite of 8 aliquots for each section for Oxygen, Nitrogen, Phosphorus, and Potassium per 5,000 sq. ft.	8			
Total per Year	8			
Clearance Per 2 year Batch Cycle				
1 Composite of 8 aliquots for each 10,000 sq. ft. section		4		
Allowance for Retest			16	
Total per treatment batch cycle		4	16	
TREATMENT CELL WATER				
Quarterly				
Sump if water present			4	
Total per year			16	
ADDITIONAL LAGOON CHARACTERIZATION		4	20	
EXCAVATION CLEARANCE BOUNDARY SOILS				
3 Composites of 8 aliquots for each of five excavations		15	15	
Retest		5	15	
QC Duplicate		3	5	
Total		23	35	
WATER TREATMENT ACTIVATED CARBON				
Monthly				
Influent			1	
Effluent				
Monthly - pH, temp, PCP	1		1	
Annually - Wet Test	1			
Primary Activated Carbon Cell Discharge			1	
Total per year (8 Months)	9		17	
WELL INSTALLATION SOILS				
PZ-17 3 levels one time			3	
PZ-18 3 levels one time			3	
Total first year			6	
CONTINGENCY SAMPLES	10	2	20	4

*note (HRC) Hydrogen Release Compound Analytes
Organic Carbon, Mn, Fe, Cl, TOC, Alkalinity

10 LIST OF FIGURES

COL. 624\015570-013

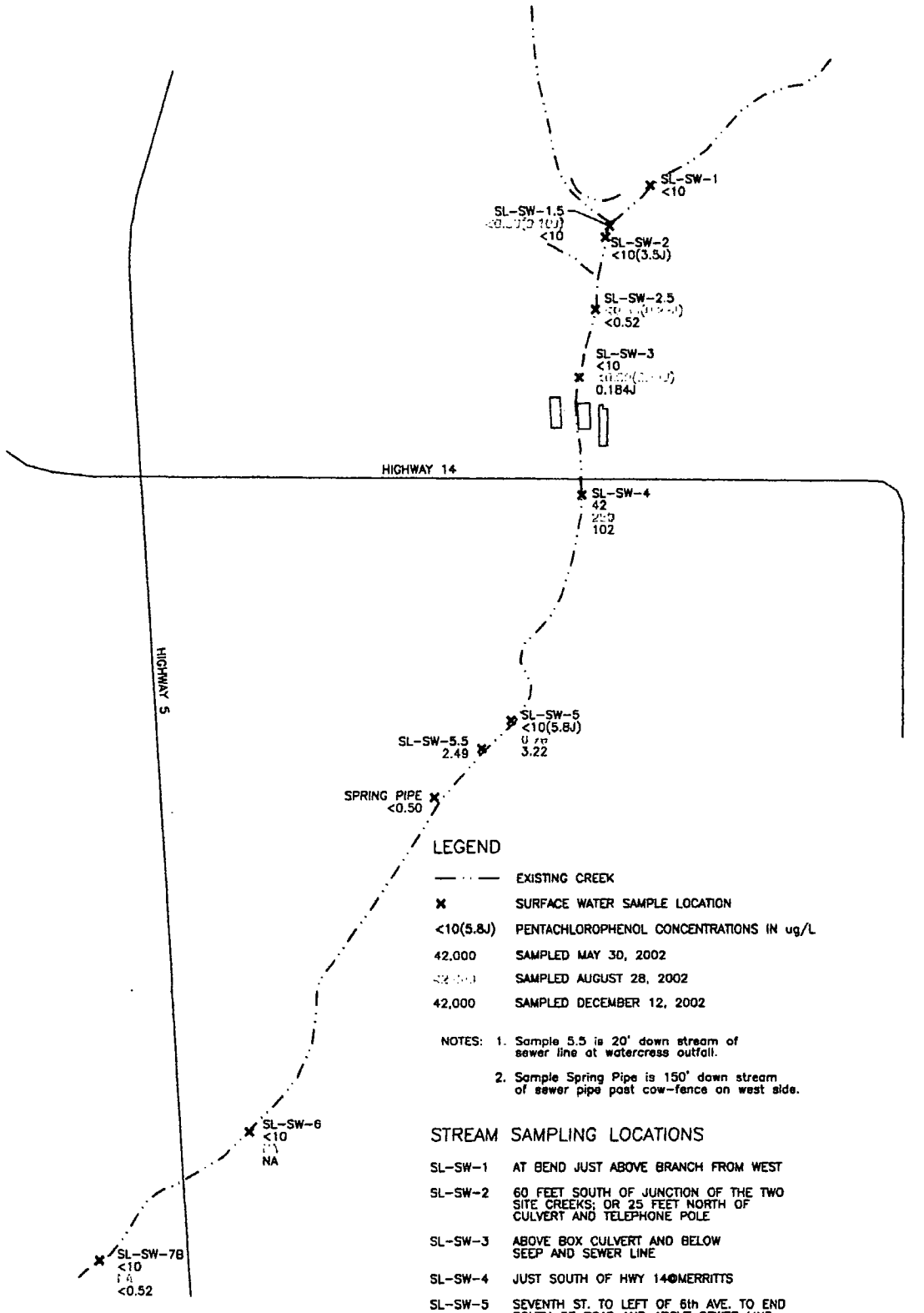


PSC

GROUNDWATER PENTACHLOROPHENOL CONCENTRATIONS
MAY 30, AUG 28 & DEC 12, 2002

DWN: TMM	DES.: DEM	PROJECT NO.: 62401557
CHKD:	APPD:	SENTINEL WOOD TREATING AVA, MISSOURI
DATE: 10/1/03	REV.: 0	FIGURE 1

COL. 624\01557A-015



LEGEND

— · · —	EXISTING CREEK
×	SURFACE WATER SAMPLE LOCATION
<10(5.8J)	PENTACHLOROPHENOL CONCENTRATIONS IN ug/L
42,000	SAMPLED MAY 30, 2002
[illegible]	SAMPLED AUGUST 28, 2002
42,000	SAMPLED DECEMBER 12, 2002

NOTES:
1. Sample 5.5 is 20' down stream of sewer line at watercress outfall.
2. Sample Spring Pipe is 150' down stream of sewer pipe past cow-fence on west side.

STREAM SAMPLING LOCATIONS

SL-SW-1	AT BEND JUST ABOVE BRANCH FROM WEST
SL-SW-2	60 FEET SOUTH OF JUNCTION OF THE TWO SITE CREEKS; OR 25 FEET NORTH OF CULVERT AND TELEPHONE POLE
SL-SW-3	ABOVE BOX CULVERT AND BELOW SEEP AND SEWER LINE
SL-SW-4	JUST SOUTH OF HWY 14@MERRITTS
SL-SW-5	SEVENTH ST. TO LEFT OF 6th AVE. TO END SOUTH OF ROAD AND ABOVE SEWER LINE
SL-SW-6	ABOVE LOW WATER CROSSING IN MIDDLE OF PARK
SL-SW-7	BELOW SEWER OUT FALL NORTH OF BEND IN ROAD NEAR LIFT STATION

0 500
FEET

N

PSC

TITLE:
SURFACE WATER PENTACHLOROPHENOL CONCENTRATIONS
MAY 30, AUG. 28 & DEC 12, 2002

DWN: TMM	DES.: DEM	PROJECT NO.: 62401557	
CHKD:	APPD:	SENTINEL WOOD TREATING AVA, MISSOURI	
DATE: 10/1/03	REV.: 0	FIGURE 2	

Health and Safety Plan Addendum

The Sentinel Wood Treating Site
Ava, Missouri

October 3, 2003
Revised August 20, 2004

Prepared for:
Sentinel Industries, Inc.

By:

Lafser & Associates, Inc.
638 Chamblee Ln.
St. Louis, Missouri 63141

TABLE OF CONTENTS

1 APPROVALS

Health and Safety Plan Addendum Approvals for the Sentinel Wood Treating Site, Ava, Missouri

Project Name: Sentinel Wood Treating Site

Project Site Location: Ava, Missouri

Project Manager (PM): Fred A. Lafser

Site Safety Officer (SSO): Roger Riemann

Date(s)/Duration of Field Work: TBD

Expiration Date:
9/30/09 or when new hazard information becomes available; whichever is sooner.

APPROVED:

L & A Health & Safety Officer

(Signature and Date)

Project Manager (PM)

(Signature and Date)

PURPOSE

The previously approved Health and Safety Plan (HASP) (approved March 5, 2002) is being updated with this addendum for the following reasons:

- Sampling events are continuing to monitor groundwater and surface water;
- Additional excavation is planned for soil remediation;
- An above-ground bioremediation treatment cell will be constructed and the soils with PCP will be biodegraded in the cell
- Pole barn or green house may be constructed over the bioremediation treatment site for moisture control.
- Hydrogen Release Compound (HRC) will be used in-situ to accelerate the biodegradation of pentachlorophenol (PCP) through the digestion of lactic acid by anaerobic microbes and the release of hydrogen ions for cleavage of the chlorine.
- Oxygen Release Compound (ORC) may be used to provide additional oxygen in the lift in the bioremediation facility for aerobic digestion of the PCP.
- Treatment of PCP in-situ in the old treatment collection sump with potassium permanganate or hydrogen peroxide.
- Trenches will be excavated, distributors installed and HRC added for in-situ anaerobic treatment.
- Possible grinding of wood "end cuts" from the lagoon area.
- Tilling of soils in the bioremediation treatment cell to maintain loft for good oxygen transfer to aerobes.

2 ADDITIONAL HEALTH AND SAFETY HAZARDS ASSOCIATED WITH RECLAMATION ACTIVITIES

- Trenching for the installation of permeable in-situ barriers
- Hazardous Atmosphere from contaminated soils
- Heavy Equipment Operation
- Confined Space Entry
- Work zone restriction areas based on type of activity and close proximity to active businesses
- Open Trenches
- Chemical Handling
- Dust from Excavation or Tilling Soils

2.1 Trenching for the installation of permeable in-situ barriers

Installation of the permeable in-situ barriers requires the excavation of soils in three areas. Each excavation will be approximately 2-3 feet wide to a depth of 12-15 feet as shown in Figure 7 "Proposed Remediation Excavation and Trench Locations..." Two of the trenches will be 100 feet and one 50 feet. Excavation will generally be by backhoe. A manifold will be assembled at grade and lowered into the trench. At this time there is no intention for entering the trench. If for some unknown reason entry was necessary, the trench in the area of entry would have to be shored. Secondly the requirements for confined space entry would have to be implemented as detailed in the HASP of 1/11/2002.

During construction of trench #2, since it is at the department store front parking lot, it will necessary to fence off and posted to prevent entry of customers into the construction site. A temporary entry to the west side of the porch may be required for entry to the business and to limit personnel in the construction area. Additionally, temporary fencing will be installed around trench #1 and #2 during construction. The trenches, after installation of the distributors and HRC compound, will be backfilled with pea gravel in the saturation zone which is estimated to be some 4-10 feet and the final 4 foot portion with soil. Caps will be installed on the distributors and secured. HRC's Material Safety Data Sheet is in the Appendix of the HASP. HRC is hydrolyzed by the ground water into lactic acid and glycerol, the lactic acid acting as a food source for the anaerobic digesters which intern produce hydrogen for reaction in stripping the chlorine radicals.

2.2 Soil Excavation by Culvert

Along the culvert between the Dollar General and Sentinel Warehouse Buildings soils will be removed for reclamation in the bioremediation treatment cell. Since this excavation is intended to be temporarily left uncovered a more permanent chain-link fence will be installed around the excavation. Entry is not necessary during or after this activity. During this excavation, soils will be excavated and moved to the bioremediation treatment cell. Soils have been shown to be clay like and not likely to create a nuisance dust hazard however if we find the soils are finely divided and subject to entrainment by wind, dust suppression by water mist will be utilized to minimize dust. Odor from the PCP and TPH may be present during the excavation. We do not believe an explosion hazard exists from the TPH concentration measured in the soils. Odor is difficult to suppress however, we will expeditiously move the soils from this excavation to the bioremediation treatment cell in the rear of the property to mitigate the issue.
An 8% solution of Potassium Permanganate will be used to treat the PCP which is in the old treatment plant sump next to this excavation. This sump has been shown to contain the highest concentrations of PCP and since it is contained, direct oxidation of this point source is feasible.
Personnel involved in the excavations who may be in contact with the soils will be provided Tyvek® coveralls and Nitrile gloves to minimize contact with the skin. Dust masks and respirators will also be available.

2.3 Excavation by backhoe.

Operators will be briefed on the hazards and safety precautions when working in the area. Subsidence issues, buried piping and cables will also be addressed. A tractor with plow and tiller appliances will be utilized to homogenize soil, fluffing agent and nutrients in the bioremediation treatment cell. Issues of working with power equipment and rotating hazards will be reviewed with the operators. Oxygen Release Compound will be added along with the ingredients to increase oxygen supply to the aerobes in the bioremediation treatment cell. ORC is a mixture of magnesium peroxide, magnesium oxide, and magnesium hydroxide which react with soil moisture to slowly release oxygen. After the reaction of the magnesium peroxide to form oxygen the resulting material, magnesium hydroxide is mildly basic. The amounts of magnesium oxide (magnesia) and magnesium hydroxide in the initial product have an effect similar to lime, but with lower alkalinity.

A grinder may be brought in during the reclamation of the lagoon area to reduce scrape wood for degradation in the bioremediation treatment cell. Grinders produce high noise during the reduction process and ear protection will be provided for activities producing high decibel noise levels. Additionally,

all safety precautions associated with this type of operation that of high r.p.m. rotating equipment will be covered.

The sides of the bioremediation treatment cell's canopy can be opened so gaseous contaminates will not build up under the covering. However, when tilling the soil skin contact with the contaminate is possible and clothing, dust mask, and goggles should be used. Tilling should be done when soil is still moist and never allowed to completely dry out. The moisture is essential for efficient bioremediation and also prevents airborne dust generation.

3 APPENDIX

MATERIAL SAFETY DATA SHEETS

- Regenesis Hydrogen Release Compound
- Regenesis Oxygen Release Compound
- Potassium Permanganate

OXYGEN RELEASE COMPOUND (ORC®)
MATERIAL SAFETY DATA SHEET (MSDS)

Last Revised : March 27, 2003

****

SECTION 1 - MATERIAL IDENTIFICATION

****

SUPPLIER:

REGENESIS

1011 Calle Sombra
San Clemente, CA 92673
949-366-8000 phone
949-366-8090 fax
info@regenesis.com e-mail

CHEMICAL DESCRIPTION:
A mixture of Magnesium Peroxide [MgO_2], Magnesium Oxide [MgO], and Magnesium Hydroxide [$Mg(OH)_2$]

CHEMICAL FAMILY:
Inorganic Chemicals

PRODUCT NAME:
Oxygen Release Compound (ORC®)

PRODUCT USE:
Used for environmental remediation of contaminated soil and groundwater

****

SECTION 2 - CHEMICAL IDENTIFICATION

****

CHEMICAL CHARACTERIZATION
Magnesium Peroxide [MgO_2]: CAS Reg. No. 14452-57-4
Magnesium Oxide [MgO]: CAS Reg. No. 1309-48-4
Magnesium Hydroxide (($Mg(OH)_2$): CAS Reg. No. 1309-42-8

FORM : powder

COLOR: white

ODOR: odorless

ASSAY: 25 - 35% Magnesium Peroxide (MgO_2)

****

SECTION 3 - PHYSICAL AND TECHNICAL SAFETY DATA

****

MELTING POINT: Not Determined

BOILING POINT: Not Determined

DENSITY: 0.6 - 0.8 g/cc

BULK DENSITY: ---

VAPOR PRESSURE: Data not available

VISCOSITY: ---

SOLUBILITY: Reacts with water. Soluble in acid

pH VALUE: Approx. 10 in saturated solution

FLASH POINT: Not applicable

SELF-IGNITION TEMPERATURE: Not applicable

EXPLOSION LIMITS % BY VOLUME: ---

THERMAL DECOMPOSITION: Spontaneous decomposition possible about 150° C

HAZARDOUS DECOMPOSITION PRODUCTS: Not known

HAZARDOUS REACTIONS: Hazardous polymerization will not occur

FURTHER INFORMATION: Non-combustible, but will support combustion

****

SECTION 4 - REACTIVITY DATA

****

STABILITY: Product is stable unless heated above 150°C. Magnesium Peroxide reacts with water to slowly release oxygen. React by product is magnesium hydroxide

CONDITIONS TO AVOID: Heat above 150°C. Open flames

INCOMPATIBILITY: Strong Acids. Strong chemical agents

HAZARDOUS POLYMERIZATION: None known

****

SECTION 5 - REGULATIONS

****

PERMISSIBLE EXPOSURE LIMITS IN AIR: Not established. Should be treated as a nuisance dust.

****

SECTION 6 - PROTECTIVE MEASURES, STORAGE, AND HANDLING

****

TECHNICAL PROTECTIVE MEASURES

STORAGE: Keep container tightly closed. Keep away from combustible material

HANDLING: Use only in well-ventilated areas

PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTION: Recommended (HEPA Filters)

HAND PROTECTION: Wear suitable gloves

EYE PROTECTION: Use chemical safety goggles

OTHER: ---

INDUSTRIAL HYGIENE: Avoid contact with skin and eyes

PROTECTION AGAINST FIRE AND EXPLOSION: ---

DISPOSAL: Dispose via sanitary landfill per state/local authority

FURTHER INFORMATION: Not flammable, but may intensify fire

****

SECTION 7 - MEASURES IN CASE OF ACCIDENTS AND FIRE

****

AFTER SPILLAGE/LEAKAGE/GAS LEAKAGE: Collect in suitable containers. Wash remainder with copious quantities of water.

EXTINGUISHING MEDIA

SUITABLE: Carbon dioxide, dry chemicals, foam

NOT TO BE USED: ---

FURTHER INFORMATION: Self contained breathing apparatus or approved gas mask should be worn due to small particle size. Use extinguishing media appropriate for surrounding fire.

FIRST AID: After contact with skin, wash immediately with plenty of water and soap. In case of contact with eyes, rinse immediately with plenty of water and seek medical attention.

FURTHER INFORMATION: ---

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SECTION 8 - INFORMATION ON TOXICOLOGY

****

TOXICITY DATA: Data not available

****

SECTION 9 - INFORMATION ON ECOLOGY

****

WATER POLLUTION HAZARD RATING (WGK): 0

****

SECTION 10 - FURTHER INFORMATION

****

After the reaction of magnesium peroxide to form oxygen the resulting material, magnesium hydroxide is mildly basic. The amounts of magnesium oxide (magnesia) and magnesium hydroxide in the initial product have an effect similar to lime, but with lower alkalinity.
The information contained in this document is the best available to the supplier at the time of writing, but is provided without warranty of any kind. Some possible hazards have been determined by analogy to similar classes of material. The items in this document are subject to change and clarification as more information becomes available.

MATERIAL SAFETY DATA SHEET

Last Revised: March 10, 2003

****

Section 1 - Material Identification

****

Supplier: Regenesis Bioremediation Products, Inc.
1011 Calle Sombra
San Clemente, CA 92673

Telephone: (949) 366-8000
Facsimile: (949) 366-8090

Chemical Name: Glycerol Tripolylactate

Chemical Family: Organic Chemical

Trade Name: Hydrogen Release Compound (HRC®)

****

Section 2 - Chemical Identification

****

CAS#	Compound	Percent Composition
201167-72-8	Glycerol Tripolylactate	52.5 - 65.0%
56-81-5	Glycerol	35.0 - 47.5%

****

Section 3 - Physical Data

****

Melting Point:	NA
Boiling Point:	ND
Flash Point:	ND
Density:	1.347
Solubility:	Acetone and DMSO
Appearance:	Amber semi-solid
Odor:	Not detectable
Vapor Pressure:	None

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Section 4 - Fire and Explosion Hazard Data

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Extinguishing Media: Carbon Dioxide, Dry Chemical Powder or Appropriate Foam.

Water may be used to keep exposed containers cool.

For large quantities involved in a fire, one should wear full protective clothing and a NIOSH approved self contained breathing apparatus with full face piece operated in the pressure demand or positive pressure mode as for a situation where lack of oxygen and excess heat are present.

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Section 5 - Toxicological Information

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Acute Effects: May be harmful by inhalation, ingestion, or skin absorption.
May cause irritation. To the best of our knowledge, the chemical, physical, and toxicological properties of the glycerol tripolylactate have not been investigated. Listed below are the toxicological information for glycerol and lactic acid.

RTECS#: MA8050000
Glycerol

Irritation data:	SKN-RBT 500 MG/24H MLD	85JCAE-,207,1986
	EYE-RBT 126 MG MLD	BIOFX* 9-4/1970
	EYE-RBT 500 MG/24H MLD	85JCAE-,207,1986
Toxicity data:	ORL-MUS LD50:4090 MG/KG	FRZKAP (6),56,1977
	SCU-RBT LD50:100 MG/KG	NIIRDN 6,215,1982
	ORL-RAT LD50:12600 MG/KG	FEPRA7 4,142,1945
	IHL-RAT LC50: >570 MG/M3/1H	BIOFX* 9-4/1970
	IPR-RAT LD50: 4420 MG/KG	RCOCB8 56,125,1987
	IVN-RAT LD50:5566 MG/KG	ARZNAD 26,1581,1976
	IPR-MUS LD50: 8700 MG/KG	ARZNAD 26,1579,1978
	SCU-MUS LD50:91 MG/KG	NIIRDN 6,215,1982
	IVN-MUS LD50: 4250 MG/KG	JAPMA8 39,583,1950
	ORL-RBT LD50: 27 GM/KG	DMDJAP 31,276,1959
	SKN-RBT LD50:>10GM/KG	BIOFX* 9-4/1970
	IVN-RBT LD50: 53 GM/KG	NIIRDN 6,215,1982
	ORL-GPG LD50: 7750 MG/KG	JIHTAB 23,259,1941

Target Organ data: Behavioral (headache), gastrointestinal (nausea or vomiting), Paternal effects (spermatogenesis, testes, epididymis, sperm duct), effects of fertility (male fertility index, post-implantation mortality).

RTECS#: OD2800000
Lactic acid

Irritation data:	SKN-RBT 5MG/24H SEV	85JCAE -,656,86
	EYE-RBT 750 UG SEV	AJOPAA 29,1363,46
Toxicity data:	ORL-RAT LD50:3543 MG/KG	FMCHA2-,C252,91
	SKN-RBT LD50:>2 GM/KG	FMCHA2-,C252,91
	ORL-MUS LD50: 4875 MG/KG	FAONAU 40,144,67
	ORL-GPG LD50: 1810 MG/KG	JIHTAB 23,259,41
	ORL-QAL LD50: >2250 MG/KG	FMCHA2-,C252,91

Only selected registry of toxic effects of chemical substances (RTECS) data is presented here. See actual entry in RTECS for complete information on lactic acid and glycerol.

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Section 6 - Health Hazard Data

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Handling: Avoid continued contact with skin.
Avoid contact with eyes.

In any case of any exposure which elicits a response, a physician should be consulted immediately.

First Aid Procedures:

Inhalation: Remove to fresh air. If not breathing give artificial respiration. In case of labored breathing give oxygen. Call a physician.

Ingestion: No effects expected. Do not give anything to an unconscious person. Call a physician immediately.

Skin Contact: Flush with plenty of water. Contaminated clothing may be washed or dry cleaned normally.

Eye contact: Wash eyes with plenty of water for at least 15 minutes lifting both upper and lower lids. Call a physician.

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Section 7 - Reactivity Data

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Conditions to Avoid: Strong oxidizing agents, bases and acids
Hazardous Polymerization: None known
Further Information: Hydrolyses in water to form Lactic Acid and Glycerol.

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Section 8 - Spill, Leak or Accident Procedures

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After Spillage or Leakage: Neutralization is not required. This combustible material may be burned in a chemical incinerator equipped with an afterburner and scrubber.

Disposal: Laws and regulations for disposal vary widely by locality. Observe all applicable regulations and laws. This material, may be disposed of in solid waste. Material is readily degradable and hydrolyses in several hours.

No requirement for a reportable quantity (CERCLA) of a spill is known.

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Section 9 - Special Protection or Handling

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Should be stored in plastic lined steel, plastic, glass, aluminum, stainless steel, or reinforced fiberglass containers.

Protective Gloves:	Vinyl or Rubber
Eyes:	Splash Goggles or Full Face Shield Area should have approved means of washing eyes.
Ventilation:	General exhaust.
Storage:	Store in cool, dry, ventilated area. Protect from imcompatible materials.

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Section 10 - Other Information

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This material will degrade in the environment by hydrolysis to lactic acid and glycerol.
Materials containing reactive chemicals should be used only by personnel with appropriate chemical training.

The information contained in this document is the best available to the supplier as of the time of writing. Some possible hazards have been determined by analogy to similar classes of material. No separate tests have been performed on the toxicity of this material. The items in this document are subject to change and clarification as more information becomes available.

SPECTRUM QUALITY PRODUCTS INC -- P4461,POTASSIUM PERMANGANATE

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MSDS Safety Information

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FSC: 6810
NIIN: 00-222-9665
MSDS Date: 06/23/1999
MSDS Num: CKCDY
Product ID: P4461,POTASSIUM PERMANGANATE
MFN: 01
Responsible Party
Cage: 63415
Name: SPECTRUM QUALITY PRODUCTS INC
Address: 14422 S SAN PEDRO ST
City: GARDENA CA 90248-2027
Info Phone Number: 310-516-8000
Emergency Phone Number: 310-516-8000

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Item Description Information

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Item Manager: S9G
Item Name: POTASSIUM PERMANGANATE,ACS
Specification Number: O-C-265B
Unit of Issue: BT
Quantitative Expression: 00000000500GM
UI Container Qty: G
Type of Container: BOTTLE

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Ingredients

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Cas: 7722-64-7
RTECS #: SD6475000
Name: POTASSIUM PERMANGANATE
Percent by Wt: 100.
Other REC Limits: NOT PROVIDED.
OSHA PEL: C5 MG/M3
ACGIH TLV: 5 MG/M3
ACGIH STEL: NOT ESTABLISHED
EPA Rpt Qty: 100 LBS
DOT Rpt Qty: 100 LBS

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Health Hazards Data

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LD50 LC50 Mixture: LD50 (ORAL, RAT) 1090 MG/KG
Route Of Entry Inds - Inhalation: YES
Skin: NO
Ingestion: YES
Carcinogenicity Inds - NTP: NO
IARC: NO
OSHA: NO
Effects of Exposure: ACUTE: VERY HAZARDOUS IN CASE OF SKIN CONTACT (IRRITANT), OF EYE CONTACT(IRRITANT), OF INGESTION, OF INHALATION. HAZARDOUS IN CASE OF SKIN CONTACT(CORROSIVE). SLIGHTLY HAZARDOUS IN CASE OF SKIN CONTAC T(PERMEATOR). PROLONGED EXPOSURE MAY RESULT IN SKIN BURNS AND ULCERATIONS. OVER-EXPOSURE BY INHALATION MAY CAUSE RESPIRATORY IRRITATION. INFLAMMATION OF THE EYE IS CHARACTERIZED BY REDNESS, WATERING, AND ITCHING. SKIN INFLAMMATION IS CHARACTERIZED BY ITCHING, SCALING, REDDENING, OR OCCASIONALLY, BLISTERING.
Explanation Of Carcinogenicity: NOT AVAILABLE. : NOT LISTED.
Signs And Symptions Of Overexposure: ACUTE: VERY HAZARDOUS IN CASE OF SKIN

CONTACT (IRRITANT), OF EYE CONTACT(IRRITANT), OF INGESTION, OF INHALATION. HAZARDOUS IN CASE OF SKIN CONTACT(CORROSIVE). SLIGHTLY HAZARDOUS IN CASE OF SKIN CONTAC T(PERMEATOR). PROLONGED EXPOSURE MAY RESULT IN SKIN BURNS AND ULCERATIONS. OVER-EXPOSURE BY INHALATION MAY CAUSE RESPIRATORY IRRITATION. INFLAMMATION OF THE EYE IS CHARACTERIZED BY REDNESS, WATERING, AND ITCHING. SKIN INFLAMMATION IS CHARACTERIZED BY ITCHING, SCALING, REDDENING, OR OCCASIONALLY, BLISTERING.

Medical Cond Aggravated By Exposure: NOT PROVIDED.

First Aid: EYE: REMOVE CONTACT LENSES. IMMEDIATELY FLUSH EYES WITH WATER FOR AT LEAST 15 MIN HOLDING EYELIDS OPEN. DO NOT USE EYE OINTMENT. GET MEDICAL HELP. SKIN: GENTLY & THOROUGHLY WASH WITH RUNNING WATER & N ON-ABRASIVE SOAP. SERIOUS CONTACT-USE A DISINFECTANT SOAP. GET MEDICAL ATTENTION. INHALATION: MOVE TO FRESH AIR. LOOSEN TIGHT CLOTHING. IF BREATHING DIFFICULT, GIVE OXYGEN. IF VICTIM NOT BREATHING, PE RFORM MOUTH-TO-MOUTH. GET IMMEDIATE MEDICAL HELP. INGESTION: DO NOT INDUCE VOMITING. LOOSEN TIGHT CLOTHING. GIVE MOUTH-TO-MOUTH IF NOT BREATHING. GET IMMEDIATE MEDICAL HELP.

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Handling and Disposal

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Spill Release Procedures: SMALL SPILL: USE APPROPRIATE TOOLS TO PUT THE SPILLED SOLID IN A CONVENIENT WASTE CONTAINER. LARGE SPILL: OXIDIZING MATERIAL. STOP LEAK IF WITHOUT RISK. AVOID CONTACT WITH COMBUSTIBLE MATERIAL (WOOD, PAPER, OIL, CLOTHING). KEEP SUBSTANCE DAMP USING WATER SPRAY. DO NOT TOUCH SPILLED MATERIAL. PREVENT ENTRY INTO SEWERS, BASEMENTS OR CONFINED AREAS; DIKE IF NEEDED. CALL FOR ASSISTANCE ON DISPOSAL.

Neutralizing Agent: NOT RELEVANT.

Waste Disposal Methods: RECYCLE TO PROCESS, IF POSSIBLE. CONSULT YOUR LOCAL OR REGIONAL AUTHORITIES.

Handling And Storage Precautions: KEEP DRY & AWAY FROM HEAT. KEEP AWAY FROM SOURCES OF IGNITION. KEEP AWAY FROM COMBUSTIBLE MATERIAL. SHOULD BE STORED IN A SEPARATE SAFETY STORAGE CABINET OR ROOM.

Other Precautions: DO NOT INGEST. DO NOT BREATHE DUST. IN CASE OF INSUFFICIENT VENTILATION, WEAR SUITABLE RESPIRATORY EQUIPMENT. IF INGESTED, SEEK MEDICAL ADVICE IMMEDIATELY AND SHOW THE CONTAINER OR THE LABEL. AVOID CO NTACT WITH SKIN AND EYES.

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Fire and Explosion Hazard Information

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Flash Point Text: NOT APPLICAPLE.

Extinguishing Media: NON-FLAMMABLE.

Fire Fighting Procedures: NON-FLAMMABLE.

Unusual Fire/Explosion Hazard: NO SPECIFIC INFORMATION IS AVAILABLE REGARDING THE PRODUCT'S RISKS OF EXPLOSION IN THE PRESENCE OF VARIOUS MATERIALS.

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Control Measures

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Respiratory Protection: BE SURE TO USE A MSHA/NIOSH APPROVED RESPIRATOR OR EQUIVALENT. A SELF CONTAINED BREATHING APPARATUS SHOULD BE USED TO AVOID INHALATION OF THE PRODUCT.

Ventilation: USE PROCESS ENCLOSURES, LOCAL EXHAUST VENTILATION, OR OTHER ENGINEERING CONTROLS TO KEEP AIRBORNE LEVELS BELOW RECOMMENDED EXPOSURE LIMITS.

Protective Gloves: IMPERVIOUS.

Eye Protection: SPLASH GOGGLES.

Other Protective Equipment: LAB COAT. FULL SUIT. DUST RESPIRATOR. BOOTS. SUGGESTED PROTECTIVE CLOTHING MIGHT NOT BE SUFFICIENT; CONSULT A SPECIALIST BEFORE HANDLING THIS PRODUCT.

Work Hygienic Practices: NOT PROVIDED.

Supplemental Safety and Health: IF USER OPERATIONS GENERATE DUST, FUME OR MIST, USE VENTILATION TO KEEP EXPOSURE TO AIRBORNE COMTAMINANTS BELOW THE EXPOSURE

LIMIT.

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Physical/Chemical Properties

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HCC: D1
NRC/State LIC No: NOT RELEVANT.
B.P. Text: NOT APPLICAPLE.
M.P/F.P Text: DECOMPOSES.
Decomp Text: NOT PROVIDED.
Vapor Pres: NOT AVAILABLE.
Spec Gravity: 2.703(WATER=1)
PH: NOT AVAILABLE.
Viscosity: NOT APPLICAPLE.
Evaporation Rate & Reference: NOT APPLICAPLE.
Solubility in Water: PARTIALLY SOLUBLE.
Appearance and Odor: SOLID.
Corrosion Rate: NOT PROVIDED.

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Reactivity Data

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Stability Indicator: YES
Stability Condition To Avoid: NO ADDITIONAL REMARK.
Materials To Avoid: NOT AVAILABLE
Hazardous Decomposition Products: NOT PROVIDED.
Hazardous Polymerization Indicator: NO
Conditions To Avoid Polymerization: NONE

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Toxicological Information

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Toxicological Information: CHRONIC EFFECTS ON HUMAN: THE SUBSTANCE IS TOXIC TO LUNGS, MUCOUS MEMBRANES.

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Ecological Information

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Ecological: THE PRODUCTS OF DEGRADATION ARE MORE TOXIC.

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MSDS Transport Information

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Transport Information: DOT CLASSIFICATION: DOT CLASS 5.1: OXIDIZER. IDENTIFICATION: POTASSIUM PERMANGANATE UN1490 I I

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Regulatory Information

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Sara Title III Information: THE FOLLOWING PRODUCT IS LISTED BY CERCLA: POTASSIUM PERMANGANATE. THE FOLLOWING PRODUCT IS LISTED ON SARA 313: POTASSIUM PERMANGANATE.
Federal Regulatory Information: THE FOLLOWING PRODUCT IS LISTED ON TSCA: POTASSIUM PERMANGANATE.
OSHA: HAZARDOUS BY DEFINITION OF HAZARD COMMUNICATION STANDARD (29 CFR 1910.1200).
State Regulatory Information: THE FOLLOWING PRODUCT IS LISTED BY THE STATE OF MASSACHUSETTS: POTASSIUM PERMANGANATE. THE FOLLOWING PRODUCT IS LISTED BY THE STATE OF PENNSYLVANIA: POTASSIUM PERMANGANATE. CALIFORNIA PROPOSITION 65: NONE.

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Other Information

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Other Information: CATALOG NUMBERS: P1370, P1373, P0195, XX272.

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Transportation Information

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Responsible Party Cage: 63415
Trans ID NO: 151536
Product ID: P4461,POTASSIUM PERMANGANATE
MSDS Prepared Date: 06/23/1999
Review Date: 02/16/2000
MFN: 1
Net Unit Weight: 1.1 LBS
Limited Quantity IND: Y
Multiple KIT Number: 0
Unit Of Issue: BT
Container QTY: G
Type Of Container: BOTTLE
Additional Data: LIMITED QUANTITIES ARE EXEMPT FROM LABELING AND PLACARDING;
UNLESS OFFERED FOR TRANSPORTATION BY AIR . SEE 49CFR 173.152. PROPER SHIPPING
NAME, UN ID NUMBER, HAZARD CLASS, AND PACKING GROUP PER MSDS.
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Detail DOT Information
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DOT PSN AU
DOT Proper Shipping Name: POTASSIUM PERMANGANATE
Hazard Class: 5.1
UN ID Num: UN1490
DOT Packaging Group: II
Label: OXIDIZER
Special Provision: B12
Packaging Exception: 152
Non Bulk Pack: 212
Bulk Pack: 240
Max Qty Pass: 5 KG
Max Qty Cargo: 25 KG
Vessel Stow Req: D
Water/Ship/Other Req: 56,58,69,106,107
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Detail IMO Information
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IMO PSN FN
IMO Proper Shipping Name: POTASSIUM PERMANGANATE
IMDG Page Number: 5173
UN Number: 1490
UN Hazard Class: 5.1
IMO Packaging Group: II
Subsidiary Risk Label: -
EMS Number: 5.1-06
MED First Aid Guide NUM: 715
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Detail IATA Information
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IATA PSN Code: URW
IATA UN ID Num: 1490
IATA Proper Shipping Name: POTASSIUM PERMANGANATE
IATA UN Class: 5.1
IATA Label: OXIDIZER
UN Packing Group: II
Packing Note Passenger: 508
Max Quant Pass: 5KG
Max Quant Cargo: 25KG
Packaging Note Cargo: 511
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Detail AFI Information

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AFI PSN Code: URW
AFI Proper Shipping Name: POTASSIUM PERMANGANATE
AFI Hazard Class: 5.1
AFI UN ID NUM: UN1490
AFI Packing Group: II
Special Provisions: P5
Back Pack Reference: A9.8
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HAZCOM Label
==========
Product ID: P4461,POTASSIUM PERMANGANATE
Cage: 63415
Company Name: SPECTRUM LABORATORY PRODUCTS INC
Street: 14422 S SAN PEDRO ST
City: GARDENA CA
Zipcode: 90248-2027
Health Emergency Phone: 310-516-8000
Label Required IND: Y
Date Of Label Review: 02/16/2000
Status Code: A
MFG Label NO: UNKNOWN.
Year Procured: 2000
Origination Code: F
Chronic Hazard IND: Y
Eye Protection IND: YES
Skin Protection IND: YES
Signal Word: WARNING
Respiratory Protection IND: NO
Health Hazard: Moderate
Contact Hazard: Moderate
Fire Hazard: None
Reactivity Hazard: None
Hazard And Precautions: TARGET ORGANS: N/P. EYE: CHECK AND REMOVE CONTACT LENSES. IMMEDIATELY FLUSH EYES WITH WATER FOR AT LEAST 15 MINUTES HOLDING EYELIDS OPEN. DO NOT USE AN EYE OINTMENT. SEEK MEDICAL ATTENTION. SKIN: GENT LY AND THOROUGHLY WASH WITH RUNNING WATER AND NON-ABRASIVE SOAP. IN CASE OF SERIOUS CONTACT, USE A DISINFECTANT SOAP AND SEEK MEDICAL ATTENTION. INHALATION: REMOVE TO FRESH AIR. LOOSEN TIGHT CLOTHING. IF BREATHING IS DIFFICULT, ADMINISTER OXYGEN. IF VICTIM IS NOT BREATHING, PERFORM MOUTH-TO-MOUTH RESUSCITATION. SEEK IMMEDIATE MEDICAL ATTENTION. INGESTION: IF CONSCIOUS, DRINK WATER OR MILK. INDUCE VOMITING. SEEK IMMEDIATE MEDICAL ATTENTION.
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